

UNITED STATES
DEPARTMENT
OF THE NAVY

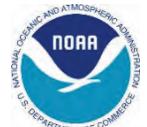


NAVAL BASE KITSAP
BANGOR
SILVERDALE, WA

COOPERATING AGENCIES:



United States Army
Corps of Engineers



National Oceanic and
Atmospheric Administration,
National Marine
Fisheries Service

LAND-WATER INTERFACE AND SERVICE PIER EXTENSION AT NAVAL BASE KITSAP BANGOR

DRAFT ENVIRONMENTAL IMPACT STATEMENT



VOLUME 2
APPENDICES A–H

FEBRUARY 2015

TABLE OF CONTENTS**VOLUME 2: APPENDICES A–H****LIST OF APPENDICES**

- A Fish and Wildlife Species Known or Expected to Occur on Naval Base Kitsap Bangor**
- B Marine Fish Life History, Habitat Conditions, and Hearing**
- C Mitigation Action Plan**
- D Noise Analysis**
- E Air Quality Emissions Calculations**
- F Traffic Analysis for Construction of Land-Water Interface and Service Pier Extension at Naval Base Kitsap Bangor**
- G Regulatory Compliance and Consultation**
- H Proxy Source Sound Levels and Potential Bubble Curtain Attenuation for Acoustic Modeling of Nearshore Marine Pile Driving at Navy Installations in Puget Sound**

This page intentionally left blank.

LIST OF ACRONYMS AND ABBREVIATIONS

°C	degrees Celsius
°F	degrees Fahrenheit
µg/kg	micrograms per kilogram
µg/m ³	micrograms per cubic meter
AAQS	ambient air quality standards
ACHP	Advisory Council on Historic Preservation
AIRFA	American Indian Religious Freedom Act
APE	Area of Potential Effect
AQI	air quality index
BMP	best management practice
BOD	biochemical oxygen demand
CAA	Clean Air Act
CCD	Coastal Consistency Determination
CDP	Census Designated Place
CDF	cumulative distribution functions
CEQ	Council on Environmental Quality
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CH ₄	methane
CO	carbon monoxide
CO ₂	carbon dioxide
CO ₂ e	carbon dioxide equivalent
COMNAVREGNWINST	Commander Navy Region Northwest Instruction
CP	current practices
CSDS-5	Commander, Submarine Development Squadron Five
CSL	Cleanup Screening Level
cu m	cubic meter
cu yd	cubic yard
CVN	aircraft carrier
CWA	Clean Water Act
CZMA	Coastal Zone Management Act
CZMP	Coastal Zone Management Program
DAHP	Department of Archaeology and Historic Preservation
dB re 1µPa	decibels referenced at 1 micropascal
dB	decibel
dBA	A-weighted decibel
DDESB	Department of Defense Explosives Safety Board
DEIS	draft environmental impact statement
DO	dissolved oxygen
DoD	Department of Defense
DPS	distinct population segment
dw	dry weight
EA	Environmental Assessment

LIST OF ACRONYMS AND ABBREVIATIONS (CONTINUED)

EFH	Essential Fish Habitat
EHW-1	Explosives Handling Wharf
EHW-2	Explosives Handling Wharf-2
EIS	environmental impact statement
EISA	Energy Independence and Security Act
ELWS	extreme low water of spring tides
EO	Executive Order
EQ	Extraordinary Quality
ESA	Endangered Species Act
ESU	evolutionarily significant unit
FEIS	final environmental impact statement
FEMA	Federal Emergency Management Agency
FMC	Fishery Management Council
FMP	Fishery Management Plan
FR	<i>Federal Register</i>
FRD	Formerly Restricted Data
ft	foot/feet
FY	fiscal year
g	gravitational acceleration
GHG	greenhouse gas
GIS	Geographic Information System
gpd	gallons per day
gpm	gallons per minute
GWP	global warming potential
HAP	hazardous air pollutants
HAPC	Habitat Areas of Particular Concern
HCCC	Hood Canal Coordinating Council
HCDOP	Hood Canal Dissolved Oxygen Program
HDPE	high density polyethylene
HLUC	Historic Land Use Complexes
HPAH	high molecular weight polycyclic aromatic hydrocarbon
Hz	hertz
IHA	Incidental Harassment Authorization
IMP	integrated management practices
IMPLAN	Impact Analysis for Planning
INRMP	Integrated Natural Resources Management Plan
JARPA	Joint Aquatic Resources Permit Application
KB	Keyport/Bangor
kHz	kilohertz
km	kilometer
kph	kilometers per hour
kVA	kilovolt-ampere
kW	kilowatt

LIST OF ACRONYMS AND ABBREVIATIONS (CONTINUED)

LAA	likely to adversely affect
LEED	Leadership in Energy and Environmental Design
Leq	equivalent sound level
LOA	Letter of Authorization
LOS	level of service
Lmax	maximum noise levels
LPAH	low molecular weight polycyclic aromatic hydrocarbon
LWI	Land-Water Interface
m	meter
MBTA	Migratory Bird Treaty Act
mg/kg	milligrams per kilogram
mg-N/kg	ammonia
mg/L	milligrams per liter
mgd	million gallons per day
MHHW	mean higher high water
MHWS	mean high water of spring tides
mi	mile
mL	milliliters
MLI	minority and low-income
MLLW	mean lower low water
mm	millimeter
MM	mitigation measures
MMO	marine mammal observer
MMPA	Marine Mammal Protection Act
MOA	Memorandum of Agreement
mph	miles per hour
MPN	most probable number
MSA	Magnuson-Stevens Fishery Conservation and Management Act
MSF	Magnetic Silencing Facility
MSGP	Multi-Sector General Permit for Stormwater Discharges Associated with Industrial Activity
MSL	mean sea level
MTCA	Model Toxics Control Act
N ₂ O	nitrous oxide
NAAQS	National Ambient Air Quality Standards
NAGPRA	Native American Graves Protection and Repatriation Act
NAM	not adversely modify
NAVBASE	Naval Base
NAVFAC	Naval Facilities Engineering Command Northwest
Navy	U.S. Department of the Navy
NBK Bangor	Naval Base Kitsap Bangor
NCP	National Oil and Hazardous Substances Contingency Plan
ND	not detected
NE	no effect
NEPA	National Environmental Policy Act

LIST OF ACRONYMS AND ABBREVIATIONS (CONTINUED)

NHPA	National Historic Preservation Act
NLAA	not likely to adversely affect
NMFS	National Marine Fisheries Service
NMFSHQ	National Marine Fisheries Service Headquarters
NMSDD	Navy Marine Species Density Database
NO ₂	nitrogen dioxide
NOA	Notice of Availability
NOAA	National Oceanic and Atmospheric Administration
NOC	Notice of Construction
NOI	Notice of Intent
NOSSA	Naval Ordnance Safety and Security Activity
NO _x	nitrogen oxides
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
NRHP	National Register of Historic Places
NSWCCD	Navy Surface Warfare Center Carderock Division
NTU	Nephelometric Turbidity Units
O ₃	ozone
OA	Operational Area
OPNAVINST	Chief of Naval Operations Instruction
OSHA	Occupational Safety and Health Administration
OU	operable unit
PAH	polycyclic aromatic hydrocarbon
PBDE	polybrominated diphenyl ether
PCB	polychlorinated biphenyl
PCE	Primary Constituent Element
PFC	properly functioning condition
PFMC	Pacific Fishery Management Council
PGA	peak ground acceleration
PM	respirable particulate matter
PM ₁₀	particulate matter less than 10 microns in diameter
PM _{2.5}	particulate matter less than 2.5 microns in diameter
PNPTT	Point No Point Treaty Tribes
PNPTC	Point No Point Treaty Council
ppm	parts per million
ppt	parts per thousand
PSAMP	Puget Sound Ambient Monitoring Program
PSAT	Puget Sound Action Team
PSB	Port Security Barrier
PSCAA	Puget Sound Clean Air Agency
PSD	prevention of significant deterioration
PSTRT	Puget Sound Technical Recovery Team
PSU	practical salinity unit
PTRCIT	Property of Traditional Religious and Cultural Importance to an Indian Tribe

LIST OF ACRONYMS AND ABBREVIATIONS (CONTINUED)

PTS	permanent threshold shift
Qal	alluvium, colluviums, and fill material
Qva	advanced outwash
Qvgl	Vashon glacio-lacustrine
Qvt	Vashon till
RCW	Revised Code of Washington
RMS	root mean square
ROD	Record of Decision
ROI	Region of Influence
SAIC	Science Applications International Corporation
SARA	Superfund Amendments and Reauthorization Act
SECNAVINST	Secretary of the Navy Instruction
SEL	Sound Exposure Level
SEPA	State Environmental Policy Act
SHPO	State Historic Preservation Officer
SIP	State Implementation Plan
SL	source level
SLR	sea level rise
SMA	Shoreline Management Act
SMP	Shoreline Management Plan
SMS	Sediment Management Standards
SO ₂	sulfur dioxide
SOx	sulfur oxides
SPCC	Spill Prevention, Control, and Countermeasure
SPE	Service Pier Extension
SPL	sound pressure level
sq ft	square feet
sq km	square kilometers
sq m	square meters
sq mi	square miles
SQS	sediment quality standards
SR	State Route
SSBN	OHIO Class Ballistic Missile submarines
SSN	SEAWOLF Class submarine (This document does not address other classes of attack submarines)
SSP	Strategic Systems Program
SUBASE	Naval Submarine Base
SWPPP	Stormwater Pollution Prevention Plan
TCP	Traditional Cultural Property
TL	transmission loss
TMDL	total maximum daily load
TOC	total organic carbon
TPP	Test Pile Program
TPS	Transit Protection System
TRIDENT	TRIDENT Fleet Ballistic Missile

LIST OF ACRONYMS AND ABBREVIATIONS (CONTINUED)

T-ROC	Thorndyke Resources Operation Complex
TSS	total suspended solids
TTS	temporary threshold shift
U&A	Usual and Accustomed
U.S.	United States
UCNI	Department of Defense Unclassified Controlled Nuclear Information
USACE	U.S. Army Corps of Engineers
USC	United States Code
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
USGBC	U.S. Green Building Council
USGS	U.S. Geological Survey
VOC	volatile organic compound
W	Watts
WAC	Washington Administrative Code
WDFW	Washington Department of Fish and Wildlife
WDNR	Washington Department of Natural Resources
WDOE	Washington Department of Ecology
WDOH	Washington Department of Health
WISAARD	Washington Information System for Architectural and Archaeological Records Data
WRA	Waterfront Restricted Area
WSDOT	Washington State Department of Transportation
WSE	Waterfront Security Enclave
ZOI	zone of influence

APPENDIX A

FISH AND WILDLIFE SPECIES KNOWN OR EXPECTED TO OCCUR ON NAVAL BASE KITSAP BANGOR

TABLE OF CONTENTS

Table A-1. Marine Fish Species Known or Expected to Occur in Hood Canal	A-1
Table A-2. Bird Species Known or Expected to Occur on NAVBASE Kitsap Bangor	A-13
Table A-3. Mammal Species Known or Expected to Occur on NAVBASE Kitsap Bangor.....	A-26
Table A-4. Amphibian and Reptile Species Known or Expected to Occur on NAVBASE Kitsap Bangor.....	A-30
Literature Cited	A-32

This page is intentionally blank.

Table A-1. Marine Fish Species Known or Expected to Occur in Hood Canal

Common Name <i>Scientific Name</i>	Common Family Name	Captured in Beach Seine ¹	Federal and State Listed Species		Essential Fish Habitat Species ²	WDFW Priority Species
			Federal Status	Washington State Status		
American shad <i>Alosa sapidissima</i>	Herrings					
Arrow goby <i>Clevelandia ios</i>	Gobies					
Arrowtooth flounder <i>Atheresthes stomias</i>	Righteye Flounders				G	
Bay goby <i>Lepidogobius lepidus</i>	Gobies					
Bay pipefish <i>Syngnathus leptorhynchus</i>	Pipefishes and Seahorses	X				
Big skate <i>Raja binoculata</i>	Skates				G	
Bigeye starsnout poacher <i>Bathyagonus pentacanthus</i>	Poachers					
Black eelpout <i>Lycodes diapterus</i>	Eelpouts					
Black rockfish <i>Sebastes melanops</i>	Scorpionfishes/Rockfishes			Candidate	G	X
Blackbelly eelpout <i>Lycodes pacifica</i>	Eelpouts					
Blackeye goby <i>Coryphopterus nicholsii</i>	Gobies					
Blackfin sculpin <i>Malacobotus kincaidi</i>	Fathead Sculpins					
Blackfin starsnout poacher <i>Bathyagonus nigripinnis</i>	Poachers					

Table A-1. Marine Fish Species Known or Expected to Occur in Hood Canal (continued)

Common Name <i>Scientific Name</i>	Common Family Name	Captured in Beach Seine ¹	Federal and State Listed Species		Essential Fish Habitat Species ²	WDFW Priority Species
			Federal Status	Washington State Status		
Blacktip poacher <i>Xeneretmus latifrons</i>	Poachers					
Bluebarred prickleback <i>Plectobranchus evides</i>	Pricklebacks					
Bluespotted poacher <i>Xeneretmus triacanthus</i>	Poachers					
Bluntnose sixgill shark <i>Hexanchus griseus</i>	Cow Sharks					
Bocaccio <i>Sebastes paucispinis</i>	Scorpaenfishes/Rockfishes		(Puget Sound/ Georgia Basin DPS) Endangered	Candidate	G	X
Brown cat shark <i>Apristurus brunneus</i>	Cat Sharks					
Brown Irish lord <i>Hemilepidotus spinosus</i>	Sculpins					
Brown rockfish <i>Sebastes auriculatus</i>	Scorpaenfishes/Rockfishes			Candidate	G	X
Buffalo sculpin <i>Enophrys bison</i>	Sculpins	X				
Bull trout <i>Salvelinus confluentus</i>	Salmonids					X
Butter sole <i>Isopsetta isolepis</i>	Righteye Flounders				G	
Cabezon <i>Scorpaenichthys marmoratus</i>	Sculpins				G	
Canary rockfish <i>Sebastes pinniger</i>	Scorpaenfishes/Rockfishes		(Puget Sound/ Georgia Basin DPS) Threatened	Candidate	G	X

Table A-1. Marine Fish Species Known or Expected to Occur in Hood Canal (continued)

Common Name <i>Scientific Name</i>	Common Family Name	Captured in Beach Seine ¹	Federal and State Listed Species		Essential Fish Habitat Species ²	WDFW Priority Species
			Federal Status	Washington State Status		
Chinook (chinook) salmon <i>Oncorhynchus tshawytscha</i>	Salmonids	X	(Puget Sound) Threatened	(Puget Sound) Candidate	S	X
Chum salmon <i>Oncorhynchus keta</i>	Salmonids	X	(Hood Canal ESU) Threatened	(Hood Canal ESU) Candidate		X
C-O turbot (sole) <i>Pleuronichthys coenosus</i>	Righteye Flounders	X				
Coho (silver) salmon <i>Oncorhynchus kisutch</i>	Salmonids	X	(Puget Sound/Strait of Georgia ESU) Concern	(Puget Sound) Candidate	S	X
Copper rockfish <i>Sebastes caurinus</i>	Scorpionfishes/Rockfishes			Candidate	G	X
Crescent gunnel <i>Pholis laeta</i>	Gunnels	X				
Cutthroat trout <i>Oncorhynchus clarki</i>	Salmonids	X	Concern			X
Decorated warbonnet <i>Chiroplophis decoratus</i>	Picklebacks					
Dolly varden <i>Salvelinus malma</i>	Salmonids					X
Dover sole <i>Microstomus pacificus</i>	Righteye Flounders	X			G	
Dusky sculpin <i>Icelinus burchami</i>	Sculpins					
Dwarf wrymouth <i>Lyconectes aleutensis</i>	Wrymouths	X				
English sole <i>Parophrys vetulus</i>	Righteye Flounders	X			G	X

Table A-1. Marine Fish Species Known or Expected to Occur in Hood Canal (continued)

Common Name <i>Scientific Name</i>	Common Family Name	Captured in Beach Seine ¹	Federal and State Listed Species		Essential Fish Habitat Species ²	WDFW Priority Species
			Federal Status	Washington State Status		
Eulachon <i>Thaleichthys pacificus</i>	Smelts	X	(Southern DPS) Threatened			X
Flathead sole <i>Hippoglossoides elassodon</i>	Righteye Flounders				G	
Fluffy sculpin <i>Oligocottus snyderi</i>	Sculpins	X				
Giant wrymouth <i>Delopeltis gigantea</i>	Wrymouths	X				
Gray starsnout poacher <i>Bathyagonus alascanus</i>	Poachers					
Great sculpin <i>Myoxocephalus polyacanthocephalus</i>	Sculpins	X				
Greenstriped rockfish <i>Sebastodes elongatus</i>	Scorpaenidae/Rockfishes			Candidate	G	X
Grunt sculpin <i>Rhamphocottus richardsonii</i>	Grunt Sculpins					
Gunnel Order – Pholididae	Gunnels	X				
High cockscomb <i>Anoplarchus purpurescens</i>	Pricklebacks					
Kelp greenling <i>Hexagrammos decagrammus</i>	Greenlings and Lingcod	X			G	
Kelp surfperch <i>Brachyistius frenatus</i>	Surfperches	X				
Lingcod <i>Ophiodon elongatus</i>	Greenlings and Lingcod	X			G	X
Longfin sculpin <i>Jordania zonope</i>	Sculpins					

Table A-1. Marine Fish Species Known or Expected to Occur in Hood Canal (continued)

Common Name <i>Scientific Name</i>	Common Family Name	Captured in Beach Seine ¹	Federal and State Listed Species		Essential Fish Habitat Species ²	WDFW Priority Species
			Federal Status	Washington State Status		
Longfin smelt <i>Spirinchus thaleichthys</i>	Smelts					X
Longnose skate <i>Raja rhina</i>	Skates				G	
Longspine combfish <i>Zaniolepis latipinnis</i>	Combfishes					
Manacled sculpin <i>Synchirus gilli</i>	Sculpins					
Market squid <i>Loligo opalescens</i>	Squid	X			CP	
Northern anchovy <i>Engraulis mordax</i>	Anchovies	X			CP	
Northern clingfish <i>Gobiesox maeandricus</i>	Clingfishes					
Northern lampfish <i>Stenobrachius leucopsarus</i>	Lanternfishes	X				
Northern rock sole <i>Lepidotretta polyxystra</i>	Righteye Flounders					
Northern ronquil <i>Ronquilus jordani</i>	Ronquils					
Northern sculpin <i>Icelinus borealis</i>	Sculpins					
Northern spearnose poacher <i>Agonopsis vulsa</i>	Poachers	X				
Pacific staghorn sculpin <i>Leptocottus armatus</i>	Sculpins					
Pacific butterfish <i>Peprilus simillimus</i>	Butterfishes					

Table A-1. Marine Fish Species Known or Expected to Occur in Hood Canal (continued)

Common Name <i>Scientific Name</i>	Common Family Name	Captured in Beach Seine ¹	Federal and State Listed Species		Essential Fish Habitat Species ²	WDFW Priority Species
			Federal Status	Washington State Status		
Pacific cod <i>Gadus macrocephalus</i>	Cods				G	X
Pacific electric ray <i>Torpedo californica</i>	Electric Rays					
Pacific hake (whiting) <i>Merluccius productus</i>	Hakes and Relatives		(Pacific-Georgia Basin DPS) Concern		G	X
Pacific halibut <i>Hippoglossus stenolepis</i>	Righeye Flounders					
Pacific herring <i>Clupea harengus pallasi</i>	Herrings	X				X
Pacific lamprey <i>Lampetra tridentata</i>	Lampreys					X
Pacific sand lance <i>Ammodytes hexapterus</i>	Sand Lances	X				X
Pacific sanddab <i>Citharichthys sordidus</i>	Lefteye Flounders	X			G	
Pacific sardine <i>Sardinops sagax</i>	Herrings	X				
Pacific snake prickleback <i>Lumpenus sagitta</i>	Pricklebacks	X				
Pacific spiny lumpsucker <i>Eumicrotremus orbis</i>	Lumpfishes					
Pacific staghorn sculpin <i>Leptocottus armatus</i>	Sculpins	X				
Pacific tomcod <i>Microgadus proximus</i>	Cods	X				
Padded sculpin <i>Artedius fenestralis</i>	Sculpins					

Table A-1. Marine Fish Species Known or Expected to Occur in Hood Canal (continued)

Common Name <i>Scientific Name</i>	Common Family Name	Captured in Beach Seine ¹	Federal and State Listed Species		Essential Fish Habitat Species ²	WDFW Priority Species
			Federal Status	Washington State Status		
Painted greenling <i>Oxylebius pictus</i>	Greenlings and Lingcod					
Pallid eelpout <i>Lycodapus mandibularis</i>	Eelpouts					
Penpoint gunnel <i>Apodichthys flavidus</i>	Gunnels	X				
Petrale sole <i>Eopsetta jordani</i>	Righteye Flounders				G	
Pile surfperch <i>Rhacochilus vacca</i>	Surfperches	X				
Pink salmon <i>Oncorhynchus gorbuscha</i>	Salmonids	X			S	X
Plainfin midshipman <i>Porichthys notatus</i>	Toadfishes	X				
Prickly sculpin <i>Cottus asper</i>	Sculpins					
Puget Sound rockfish <i>Sebastes emphaeus</i>	Scorpionfishes/Rockfishes				G	
Pygmy poacher <i>Odontopyxis trispinosa</i>	Poachers	X				
Quillback rockfish <i>Sebastes maliger</i>	Scorpionfishes/Rockfishes			Candidate	G	X
Quillfish <i>Ptilichthys goodei</i>	Quillfish					
Red brotula <i>Brosmophycis marginata</i>	Viviparous Brotulas					
Red Irish lord <i>Hemilepidotus hemilepidotus</i>	Sculpins	X				

Table A-1. Marine Fish Species Known or Expected to Occur in Hood Canal (continued)

Common Name <i>Scientific Name</i>	Common Family Name	Captured in Beach Seine ¹	Federal and State Listed Species		Essential Fish Habitat Species ²	WDFW Priority Species
			Federal Status	Washington State Status		
Redbanded rockfish <i>Sebastodes babcocki</i>	Scorpionfishes/Rockfishes				G	
Redstripe rockfish <i>Sebastodes proriger</i>	Scorpionfishes/Rockfishes			Candidate	G	X
Rex sole <i>Glyptocephalus zachirus</i>	Righteye Flounders	X			G	
Ribbed sculpin <i>Triglops pingelii</i>	Sculpins					
Ribbon snailfish <i>Liparis cyclopus</i>	Snailfishes	X				
River lamprey <i>Lampetra ayresii</i>	Lampreys					
Rockfish (juv.) <i>Sebastodes</i> spp.		X			G	
Rock greenling <i>Hexagrammos lagocephalus</i>	Greenlings					
Rock sole <i>Lepidopsetta bilineata</i>	Righteye Flounders				G	X
Roughback sculpin <i>Chitonotus pugetensis</i>	Sculpins					
Roughspine sculpin <i>Triglops macellus</i>	Sculpins					
Sablefish <i>Anoplopoma fimbria</i>	Sablefishes/Skillfishes				G	
Saddleback gunnel <i>Pholis ornata</i>	Gunnels	X				
Sailfin sculpin <i>Nautichthys oculofasciatus</i>	Searavens	X				

Table A-1. Marine Fish Species Known or Expected to Occur in Hood Canal (continued)

Common Name <i>Scientific Name</i>	Common Family Name	Captured in Beach Seine ¹	Federal and State Listed Species		Essential Fish Habitat Species ²	WDFW Priority Species
			Federal Status	Washington State Status		
Sand sole <i>Psetta melanostictus</i>	Righteye Flounders	X			G	
Scalyhead sculpin <i>Artedius harringtoni</i>	Sculpins					
Sculpin spp. Order – Cottidae		X				
Sharpchin rockfish <i>Sebastodes zacentrus</i>	Scorpionfishes/Rockfishes				G	
Sharpnose sculpin <i>Clinocottus acuticeps</i>	Sculpins					
Shiner surfperch <i>Cymatogaster aggregata</i>	Surfperches	X				
Shortfin eelpout <i>Lycodes brevipes</i>	Eelpouts					
Shortspine thornyhead <i>Sebastolobus alascanus</i>	Scorpionfishes/Rockfishes					
Showy snailfish <i>Liparis pulchellus</i>	Snailfishes					
Silvergray rockfish <i>Sebastodes brevispinis</i>	Scorpionfishes/Rockfishes				G	
Sixgill shark <i>Hexanchus griseus</i>	Cow Sharks					
Slender cockscomb <i>Anoplarchus insignis</i>	Picklebacks					
Slender snipe eel <i>Nemichthys scolopaceus</i>	Snipe Eels					
Slender sole <i>Lyopsetta exilis</i>	Righteye Flounders					

Table A-1. Marine Fish Species Known or Expected to Occur in Hood Canal (continued)

Common Name <i>Scientific Name</i>	Common Family Name	Captured in Beach Seine ¹	Federal and State Listed Species		Essential Fish Habitat Species ²	WDFW Priority Species
			Federal Status	Washington State Status		
Slim sculpin <i>Radulinus asprellus</i>	Sculpins					
Smooth alligatorfish <i>Anoplagonus inermis</i>	Poachers					
Smoothhead sculpin <i>Artedius lateralis</i>	Sculpins					
Snake prickleback <i>Lumpenus sagitta</i>	Pricklebacks	X				
Sockeye (red) salmon <i>Oncorhynchus nerka</i>	Salmonids	X				X
Soft sculpin <i>Psychrolutes sigalutes</i>	Fathead Sculpins					
Sole spp. Order – Pleuronectiformes	Righteye Flounders	X				
Southern rock sole <i>Lepidopsetta bilineata</i>	Righteye Flounders					
Speckled sanddab <i>Citharichthys stigmatus</i>	Lefteye Flounders	X				
Spiny dogfish <i>Squalus acanthias</i>	Dogfish Sharks				G	
Spinycheek starsnout poacher <i>Bathyagonus infraspinatus</i>	Poachers					
Spinyhead sculpin <i>Dasy cottus setiger</i>	Fathead Sculpins					
Splitnose rockfish <i>Sebastodes diploproa</i>	Scorpionfishes/Rockfishes				G	
Spinynose sculpin <i>Dasy cottus setiger</i>	Sculpins					

Table A-1. Marine Fish Species Known or Expected to Occur in Hood Canal (continued)

Common Name <i>Scientific Name</i>	Common Family Name	Captured in Beach Seine ¹	Federal and State Listed Species		Essential Fish Habitat Species ²	WDFW Priority Species
			Federal Status	Washington State Status		
Spotfin sculpin <i>Icelinus tenuis</i>	Sculpins					
Spotted ratfish <i>Hyrolagus colliei</i>	Chimeras					
Starry flounder <i>Platichthys stellatus</i>	Righteye Flounders	X			G	
Steelhead <i>Oncorhynchus mykiss</i>	Salmonids	X	(Puget Sound) Threatened			X
Striped surfperch <i>Embiotoca lateralis</i>	Surfperches	X				
Stripetail rockfish <i>Sebastes saxicola</i>	Scorpaenidae/Rockfishes				G	
Sturgeon poacher <i>Agonus acipenserinus</i>	Poachers	X				
Surf smelt <i>Hypomesus pretiosus</i>	Smelts	X				X
Tadpole sculpin <i>Psychrolutes paradoxus</i>	Fathead Sculpins					
Threadfin sculpin <i>Icelinus filamentosus</i>	Sculpins					
Threespine stickleback <i>Gasterosteus aculeatus</i>	Sticklebacks	X				
Tidepool sculpin <i>Oligocottus maculosus</i>	Sculpins	X				
Tubesnout <i>Aulorhynchus flavidus</i>	Tubesnouts	X				
Vermillion rockfish <i>Sebastes miniatus</i>	Scorpaenidae/Rockfishes				G	

Table A-1. Marine Fish Species Known or Expected to Occur in Hood Canal (continued)

Common Name <i>Scientific Name</i>	Common Family Name	Captured in Beach Seine ¹	Federal and State Listed Species		Essential Fish Habitat Species ²	WDFW Priority Species
			Federal Status	Washington State Status		
Walleye pollock <i>Theragra chalcogramma</i>	Cods	X		(S. Puget Sound) Candidate		X
Wattled eelpout <i>Lycodes palearis</i>	Eelpouts					
White sturgeon <i>Acipenser transmontanus</i>	Sturgeons					X
Whitebarred prickleback <i>Poroclinus rothrocki</i>	Pricklebacks					
Whitespotted greenling <i>Hexagrammos stelleri</i>	Greenlings and Lingcod	X				
Wolf-eel <i>Anarrhichthys ocellatus</i>	Wolfishes					
Yelloweye rockfish <i>Sebastes ruberrimus</i>	Scorpionfishes/Rockfishes		(Puget Sound/ Georgia Basin DPS) Threatened	Candidate	G	X
Yellowtail rockfish <i>Sebastes flavidus</i>	Scorpionfishes/Rockfishes			Candidate	G	X

Sources: University of Washington 2000; Palsson 2007, personal communication; Puget Sound Action Team 2007; REEF 2008; WDFW 2008a, b, c; Bhuthimethee et al. 2009; WDFW 2013.

1. SAIC 2006; Bhuthimethee et al. 2009.

2. CP = Coastal pelagic, DPS = Distinct Population Segment, ESU = Evolutionarily Significant Unit, G = Groundfish, S = Salmon.

Table A-2. Bird Species Known or Expected to Occur on NAVBASE Kitsap Bangor

Common Name <i>Scientific Name</i>	Season(s) of Occurrence	Federal and State Listed Species		PIF Bird of Conservation Concern? ¹	USFWS Bird of Conservation Concern? ²	WDFW Priority Species? ³
		Federal Status	Washington State Status			
Shorebirds and Wading Birds						
Great blue heron <i>Ardea herodias</i>	year-round					X
Black-bellied plover <i>Pluvialis squatarola</i>	fall and spring migrant and winter resident					
Semipalmated plover <i>Charadrius semipalmatus</i>	fall and spring migrant					
Killdeer <i>Charadrius vociferus</i>	year-round					
Greater yellowlegs <i>Tringa melanoleuca</i>	fall and spring migrant					
Lesser yellowlegs <i>Tringa flavipes</i>	fall migrant				X	
Spotted sandpiper <i>Actitis macularius</i>	summer resident					
Ruddy turnstone <i>Arenaria interpres</i>	fall and spring migrant					
Black turnstone <i>Arenaria melanocephala</i>	migrant and winter resident					
Wandering tattler <i>Tringa incana</i>	fall and spring migrant					
Sanderling <i>Calidris alba</i>	migrant and winter resident					
Western sandpiper <i>Calidris mauri</i>	fall and spring migrant					
Least sandpiper <i>Calidris minutilla</i>	fall and spring migrant					

Table A-2. Bird Species Known or Expected to Occur on NAVBASE Kitsap Bangor (continued)

Common Name <i>Scientific Name</i>	Season(s) of Occurrence	Federal and State Listed Species		PIF Bird of Conservation Concern? ¹	USFWS Bird of Conservation Concern? ²	WDFW Priority Species? ³
		Federal Status	Washington State Status			
Pectoral sandpiper <i>Calidris melanotos</i>	fall migrant					
Dunlin <i>Calidris alpina</i>	fall and spring migrant					
Short-billed dowitcher <i>Limnodromus griseus</i>	fall and spring migrant				X	
Long-billed dowitcher <i>Limnodromus scolopaceus</i>	fall and spring migrant					
Wilson's snipe <i>Gallinago delicata</i>	fall and spring migrant					
Red-necked phalarope <i>Phalaropus lobatus</i>	fall and spring migrant					
Marine Waterfowl						
Red-throated loon <i>Gavia stellata</i>	fall and spring migrant, winter resident					
Pacific loon <i>Gavia pacifica</i>	winter resident					
Common loon <i>Gavia immer</i>	winter resident		Sensitive			
Yellow-billed loon <i>Gavia adamsii</i>	winter resident				X	
Pied-billed grebe <i>Podilymbus podiceps</i>	year-round					
Horned grebe <i>Podiceps auritus</i>	winter resident					
Eared grebe <i>Podiceps nigricollis</i>	winter resident					

Table A-2. Bird Species Known or Expected to Occur on NAVBASE Kitsap Bangor (continued)

Common Name <i>Scientific Name</i>	Season(s) of Occurrence	Federal and State Listed Species		PIF Bird of Conservation Concern? ¹	USFWS Bird of Conservation Concern? ²	WDFW Priority Species? ³
		Federal Status	Washington State Status			
Red-necked grebe <i>Podiceps grisegena</i>	winter resident					
Western grebe <i>Aechmophorus occidentalis</i>	winter resident		Candidate		X	
Canada goose <i>Branta canadensis</i>	year-round					
Brant <i>Branta bernicla</i>	fall and spring migrant, winter resident					X
Snow goose <i>Chen caerulescens</i>	winter resident					
White-fronted goose <i>Anser albifrons</i>	fall and spring migrant					
Trumpeter swan <i>Cygnus buccinator</i>	fall and spring migrant, winter resident					
Wood duck <i>Aix sponsa</i>	year-round, but less common in winter					X
Gadwall <i>Anas strepera</i>	year-round					
Northern pintail <i>Anas acuta</i>	winter resident					
Eurasian wigeon <i>Anas penelope</i>	winter resident					
American wigeon <i>Anas americana</i>	winter resident					
Northern shoveler <i>Anas clypeata</i>	year-round					

Table A-2. Bird Species Known or Expected to Occur on NAVBASE Kitsap Bangor (continued)

Common Name <i>Scientific Name</i>	Season(s) of Occurrence	Federal and State Listed Species		PIF Bird of Conservation Concern? ¹	USFWS Bird of Conservation Concern? ²	WDFW Priority Species? ³
		Federal Status	Washington State Status			
Mallard <i>Anas platyrhynchos</i>	year-round					
Green-winged teal <i>Anas crecca</i>	fall and spring migrant, winter resident					
Canvasback <i>Aythya valisineria</i>	winter resident					
Greater scaup <i>Aythya marila</i>	fall and spring migrant, winter resident					
Lesser scaup <i>Aythya affinis</i>	fall and spring migrant, winter resident					
Long-tailed duck <i>Clangula hyemalis</i>	winter resident					
Surf scoter <i>Melanitta perspicillata</i>	winter resident, and non-breeding flocks in summer					
White-winged scoter <i>Melanitta fusca</i>	winter resident, and non-breeding flocks in summer					
Black scoter <i>Melanitta nigra</i>	winter resident					
Bufflehead <i>Bucephala albeola</i>	winter resident					X
Common goldeneye <i>Bucephala clangula</i>	winter resident					X
Barrow's goldeneye <i>Bucephala islandica</i>	winter resident					X

Table A-2. Bird Species Known or Expected to Occur on NAVBASE Kitsap Bangor (continued)

Common Name <i>Scientific Name</i>	Season(s) of Occurrence	Federal and State Listed Species		PIF Bird of Conservation Concern? ¹	USFWS Bird of Conservation Concern? ²	WDFW Priority Species? ³
		Federal Status	Washington State Status			
Hooded merganser <i>Lophodytes cucullatus</i>	year-round					X
Common merganser <i>Mergus merganser</i>	year-round					
Red-breasted merganser <i>Mergus serrator</i>	winter resident					
Ruddy duck <i>Oxyura jamaicensis</i>	winter resident					
American coot <i>Fulica americana</i>	year-round					
Seabirds						
Parasitic jaeger <i>Stercorarius parasiticus</i>	fall migrant, follows common tern migration					
Bonaparte's gull <i>Chroicocephalus philadelphia</i>	fall and spring migrant					
Ring-billed gull <i>Larus delawarensis</i>	fall and spring migrant, summer resident					
Mew gull <i>Larus canus</i>	winter resident					
Glaucous-winged gull <i>Larus glaucescens</i>	year-round					
Herring gull <i>Larus argentatus</i>	winter resident					
Thayer's gull <i>Larus thayeri</i>	fall and spring migrant, winter resident					

Table A-2. Bird Species Known or Expected to Occur on NAVBASE Kitsap Bangor (continued)

Common Name <i>Scientific Name</i>	Season(s) of Occurrence	Federal and State Listed Species		PIF Bird of Conservation Concern? ¹	USFWS Bird of Conservation Concern? ²	WDFW Priority Species? ³
		Federal Status	Washington State Status			
Caspian tern <i>Hydroprogne caspia</i>	non-breeding summer resident				X	
Common tern <i>Sterna hirundo</i>	fall migrant					
Brant's cormorant <i>Phalacrocorax penicillatus</i>	year-round		Candidate			
Double-crested cormorant <i>Phalacrocorax auritus</i>	year-round					
Pelagic cormorant <i>Phalacrocorax pelagicus</i>	year-round				X	
Common murre <i>Uria aalge</i>	common in winter, but uncommon to absent in summer		Candidate			
Pigeon guillemot <i>Cephus columba</i>	year-round, numbers greater in winter than summer					
Marbled murrelet <i>Brachyramphus marmoratus</i>	year-round	Threatened	Threatened			X
Ancient murrelet <i>Synthliboramphus antiquus</i>	late-fall to early- winter resident					
Cassin's auklet <i>Ptychoramphus aleuticus</i>	rare to uncommon visitor in summer and fall		Candidate			X
Rhinocerous auklet <i>Cerorhinca monocerata</i>	summer resident					

Table A-2. Bird Species Known or Expected to Occur on NAVBASE Kitsap Bangor (continued)

Common Name <i>Scientific Name</i>	Season(s) of Occurrence	Federal and State Listed Species		PIF Bird of Conservation Concern? ¹	USFWS Bird of Conservation Concern? ²	WDFW Priority Species? ³
		Federal Status	Washington State Status			
Raptors						
Bald eagle <i>Haliaeetus leucocephalus</i>	year-round		Sensitive		X	X
Osprey <i>Pandion haliaetus</i>	summer resident					
Northern harrier <i>Circus cyaneus</i>	winter resident					
Sharp-shinned hawk <i>Accipiter striatus</i>	fall migrant					
Cooper's hawk <i>Accipiter cooperii</i>	fall migrant			X		
Red-tailed hawk <i>Buteo jamaicensis</i>	year-round					
Rough-legged hawk <i>Buteo lagopus</i>	winter resident					
Merlin <i>Falco columbarius</i>	fall migrant		Candidate			
Peregrine falcon <i>Falco peregrinus</i>	fall migrant		Sensitive		X	
Turkey vulture <i>Cathartes aura</i>	summer resident					
Great horned owl <i>Bubo virginianus</i>	year-round					
Barn owl <i>Tyto alba</i>	year-round					

Table A-2. Bird Species Known or Expected to Occur on NAVBASE Kitsap Bangor (continued)

Common Name <i>Scientific Name</i>	Season(s) of Occurrence	Federal and State Listed Species		PIF Bird of Conservation Concern? ¹	USFWS Bird of Conservation Concern? ²	WDFW Priority Species? ³
		Federal Status	Washington State Status			
Snowy owl <i>Bubo scandiacus</i>	winter resident					
Western screech-owl <i>Megascops kennicottii</i>	year-round					
Barred owl <i>Strix varia</i>	year-round					
Northern saw-whet owl <i>Aegolius acadicus</i>	year-round					
Northern pygmy owl <i>Glaucidium gnoma</i>	year-round					
Other Terrestrial Birds						
Ruffed grouse <i>Bonasa umbellus</i>	year-round			X		
Blue grouse <i>Dendragapus obscurus</i>	year-round			X		
Ring-necked pheasant <i>Phasianus colchicus</i>	year-round					
California quail <i>Callipepla californica</i>	year-round					
Mountain quail <i>Oreortyx pictus</i>	year-round					X
Common nighthawk <i>Chordeiles minor</i>	summer resident					
Rock pigeon <i>Columba livia</i>	year-round					
Mourning dove <i>Zenaida macroura</i>	year-round					

Table A-2. Bird Species Known or Expected to Occur on NAVBASE Kitsap Bangor (continued)

Common Name <i>Scientific Name</i>	Season(s) of Occurrence	Federal and State Listed Species		PIF Bird of Conservation Concern? ¹	USFWS Bird of Conservation Concern? ²	WDFW Priority Species? ³
		Federal Status	Washington State Status			
Band-tailed pigeon <i>Patagioenas fasciata</i>	common summer, uncommon winter resident			X		
Vaux's swift <i>Chaetura vauxi</i>	summer resident		Candidate			X
Anna's hummingbird <i>Calypte anna</i>	year-round					
Rufous hummingbird <i>Selasphorus rufus</i>	summer resident			X	X	
Belted kingfisher <i>Megaceryle alcyon</i>	year-round					
Red-breasted sapsucker <i>Sphyrapicus ruber</i>	year-round			X		
Hairy woodpecker <i>Picoides villosus</i>	year-round					
Downy woodpecker <i>Picoides pubescens</i>	year-round					
Northern flicker <i>Colaptes auratus</i>	year-round					
Pileated woodpecker <i>Dryocopus pileatus</i>	year-round		Candidate			X
Olive-sided flycatcher <i>Contopus cooperi</i>	summer resident			X	X	
Willow flycatcher <i>Empidonax traillii</i>	summer resident			X	X	

Table A-2. Bird Species Known or Expected to Occur on NAVBASE Kitsap Bangor (continued)

Common Name <i>Scientific Name</i>	Season(s) of Occurrence	Federal and State Listed Species		PIF Bird of Conservation Concern? ¹	USFWS Bird of Conservation Concern? ²	WDFW Priority Species? ³
		Federal Status	Washington State Status			
Hammond's flycatcher <i>Empidonax hammondi</i>	summer resident					
Pacific-slope flycatcher <i>Empidonax difficilis</i>	summer resident					
Hutton's vireo <i>Vireo huttoni</i>	year-round					
Gray jay <i>Perisoreus canadensis</i>	year-round					
Steller's jay <i>Cyanocitta stelleri</i>	year-round					
American crow <i>Corvus brachyrhynchos</i>	year-round					
Common raven <i>Corvus corax</i>	year-round					
Purple martin <i>Progne subis</i>	summer resident		Candidate			X
Tree swallow <i>Tachycineta bicolor</i>	summer resident					
Violet-green swallow <i>Tachycineta thalassina</i>	summer resident					
Cliff swallow <i>Petrochelidon pyrrhonota</i>	summer resident					
Barn swallow <i>Hirundo rustica</i>	summer resident					
Black-capped chickadee <i>Poecile atricapillus</i>	year-round					

Table A-2. Bird Species Known or Expected to Occur on NAVBASE Kitsap Bangor (continued)

Common Name <i>Scientific Name</i>	Season(s) of Occurrence	Federal and State Listed Species		PIF Bird of Conservation Concern? ¹	USFWS Bird of Conservation Concern? ²	WDFW Priority Species? ³
		Federal Status	Washington State Status			
Chestnut-backed chickadee <i>Poecile rufescens</i>	year-round					
Bushtit <i>Psaltriparus minimus</i>	year-round					
Red-breasted nuthatch <i>Sitta canadensis</i>	year-round					
Brown creeper <i>Certhia americana</i>	year-round					
Bewick's wren <i>Thryomanes bewickii</i>	year-round					
Winter wren <i>Troglodytes troglodytes</i>	year-round					
Marsh wren <i>Cistothorus palustris</i>	summer resident					
American dipper <i>Cinclus mexicanus</i>	year-round					
Golden-crowned kinglet <i>Regulus satrapa</i>	summer resident			X		
Ruby-crowned kinglet <i>Regulus calendula</i>	migrant, winter resident					
Swainson's thrush <i>Catharus ustulatus</i>	summer resident					
American robin <i>Turdus migratorius</i>	year-round					
Varied thrush <i>Ixoreus naevius</i>	summer resident					

Table A-2. Bird Species Known or Expected to Occur on NAVBASE Kitsap Bangor (continued)

Common Name <i>Scientific Name</i>	Season(s) of Occurrence	Federal and State Listed Species		PIF Bird of Conservation Concern? ¹	USFWS Bird of Conservation Concern? ²	WDFW Priority Species? ³
		Federal Status	Washington State Status			
European starling <i>Sturnus vulgaris</i>	year-round					
Yellow warbler <i>Dendroica petechia</i>	summer resident					
Yellow-rumped warbler <i>Dendroica coronata</i>	summer resident					
Townsend's warbler <i>Dendroica townsendi</i>	summer resident					
MacGillivray's warbler <i>Oporornis tolmiei</i>	summer resident					
Common yellowthroat <i>Geothlypis trichas</i>	summer resident					
Wilson's warbler <i>Wilsonia pusilla</i>	summer resident					
Western tanager <i>Piranga ludoviciana</i>	summer resident					
Spotted towhee <i>Pipilo maculatus</i>	summer resident					
Song sparrow <i>Melospiza melodia</i>	year-round					
White-crowned sparrow <i>Zonotrichia leucophrys</i>	summer resident					
Golden-crowned sparrow <i>Zonotrichia atricapilla</i>	migrant, summer resident					
Fox sparrow <i>Passerella iliaca</i>	winter resident					

Table A-2. Bird Species Known or Expected to Occur on NAVBASE Kitsap Bangor (continued)

Common Name <i>Scientific Name</i>	Season(s) of Occurrence	Federal and State Listed Species		PIF Bird of Conservation Concern? ¹	USFWS Bird of Conservation Concern? ²	WDFW Priority Species? ³
		Federal Status	Washington State Status			
Dark-eyed junco <i>Junco hyemalis</i>	year-round					
Red-winged blackbird <i>Agelaius phoeniceus</i>	summer resident					
Brewer's blackbird <i>Euphagus cyanocephalus</i>	year-round					
Brown-headed cowbird <i>Molothrus ater</i>	migrant, summer resident					
Purple finch <i>Carpodacus purpureus</i>	year-round			X	X	
House finch <i>Carpodacus mexicanus</i>	year-round					
Red crossbill <i>Loxia curvirostra</i>	year-round			X		
Pine siskin <i>Spinus pinus</i>	year-round					
American goldfinch <i>Spinus tristis</i>	year-round					
Evening grosbeak <i>Coccothraustes vespertinus</i>	summer resident					
House sparrow <i>Passer domesticus</i>	year-round					

Sources: Taber and Raedeke 1983; Opperman 2003; Wahl et al. 2005; Nysewander et al. 2005; Kitsap Audubon Society 2008; Agness and Tannenbaum 2009a; WDFW 2013.

1. Altman 1999a, 1999b.
2. USFWS 2008, Tables 6 and 39.
3. WDFW 2008c.

Table A-3. Mammal Species Known or Expected to Occur on NAVBASE Kitsap Bangor

Common Name	Scientific Name	Season(s) of Occurrence	Federal and State Listed Species		WDFW Priority Species? ¹
			Federal Status	Washington State Status	
Marine Mammals					
Gray whale	<i>Eschrichtius robustus</i>	year-round (rare)		Sensitive	X
Minke whale	<i>Balaenoptera acutorostrata</i>	spring, summer and fall (rare)			
Humpback whale	<i>Megaptera novaeangliae</i>	spring and fall (rare)	Endangered	Endangered	X
Killer whale (Southern Resident)	<i>Orcinus orca</i>	year-round (rare)	Endangered	Endangered	X
Killer whale (Transient)	<i>Orcinus orca</i>	year-round (rare)			X
Dall's porpoise	<i>Phocoenoides dalli</i>	year-round (infrequent)			X
Harbor porpoise	<i>Phocoena phocoena</i>	year-round (rare)		Candidate	X
Harbor seal	<i>Phoca vitulina richardsi</i>	year-round (common, resident species)			X
Northern elephant seal	<i>Mirounga angustirostris</i>	summer and fall (rare)			
California sea lion	<i>Zalophus californianus californianus</i>	fall to late spring (common)			X
Steller sea lion	<i>Eumetopias jubatus</i>	October to June (seasonal)		Threatened	
Game					
Cougar	<i>Felis concolor</i>	year-round			
Bobcat	<i>Lynx rufus</i>	year round			
Black bear	<i>Ursus americanus</i>	early spring to fall (active), and winter hibernation			
Columbian black-tailed deer	<i>Odocoileus hemionus columbianus</i>	year-round			X

Table A-3. Mammal Species Known or Expected to Occur on NAVBASE Kitsap Bangor (continued)

Common Name	Scientific Name	Season(s) of Occurrence	Federal and State Listed Species		WDFW Priority Species? ¹
			Federal Status	Washington State Status	
Non-Game					
Virginia opossum	<i>Didelphis virginiana</i>	year-round			
Feral dog	<i>Canis familiaris</i>	year-round			
Feral cat	<i>Felis catus</i>	year-round			
Masked shrew	<i>Sorex cinereus</i>	year-round			
Vagrant shrew	<i>Sorex vagrans</i>	year-round			
Trowbridge's shrew	<i>Sorex trowbridgii</i>	year-round			
Coast mole	<i>Scapanus orarius</i>	year-round			
Myotis bats	<i>Myotis spp.</i>	year-round			X
Hoary bat	<i>Lasiurus cinereus</i>	year-round			
Silver-haired bat	<i>Lasionycteris noctivagans</i>	year-round			
Big brown bat	<i>Eptesicus fuscus</i>	year-round			
Townsend's big-eared bat	<i>Corynorhinus townsendii</i>	year-round	Species of concern	Candidate	X
Snowshoe hare	<i>Lepus americanus</i>	year-round			
Mountain beaver	<i>Aplodontia rufa</i>	year-round			
Townsend's chipmunk	<i>Tamias townsendii</i>	year-round			
Eastern gray squirrel	<i>Sciurus carolinensis</i>	year-round			
Douglas squirrel	<i>Tamiasciurus douglasii</i>	year-round			
Northern flying squirrel	<i>Glaucomys sabrinus</i>	year-round			
Beaver	<i>Castor canadensis</i>	year-round			

Table A-3. Mammal Species Known or Expected to Occur on NAVBASE Kitsap Bangor (continued)

Common Name	Scientific Name	Season(s) of Occurrence	Federal and State Listed Species		WDFW Priority Species? ¹
			Federal Status	Washington State Status	
Bushy-tailed woodrat	<i>Neotoma cinerea</i>	year-round			
Forest deer mouse	<i>Peromyscus keeni</i>	year-round			
Deer mouse	<i>Peromyscus maniculatus</i>	year-round			
Gapper's red-backed vole	<i>Clethrionomys gapperi</i>	year-round			
Long-tailed vole	<i>Microtus longicaudus</i>	year-round			
Townsend's vole	<i>Microtus townsendii</i>	year-round			
Creeping vole	<i>Microtus oregoni</i>	year-round			
Pacific jumping mouse	<i>Zapus trinotatus</i>	year-round			
Muskrat	<i>Ondatra zibethicus</i>	year-round			
Porcupine	<i>Erethizon dorsatum</i>	year-round			
Nutria	<i>Myocastor coypus</i>	year-round			
House mouse	<i>Mus musculus</i>	year-round			
Norway rat	<i>Rattus norvegicus</i>	year-round			
Black rat	<i>Rattus rattus</i>	year-round			
Coyote	<i>Canis latrans</i>	year-round			
Red fox	<i>Vulpes vulpes</i>	year-round			
Raccoon	<i>Procyon lotor</i>	year-round			
Ermine	<i>Mustela erminea</i>	year-round			
Long-tailed weasel	<i>Mustela frenata</i>	year-round			
Mink	<i>Mustela vison</i>	year-round			

Table A-3. Mammal Species Known or Expected to Occur on NAVBASE Kitsap Bangor (continued)

Common Name	Scientific Name	Season(s) of Occurrence	Federal and State Listed Species		WDFW Priority Species? ¹
			Federal Status	Washington State Status	
Striped skunk	<i>Mephitis mephitis</i>	year-round			
Western spotted skunk	<i>Spilogale gracilis</i>	year-round			
River otter	<i>Lutra canadensis</i>	year-round			

Sources: Osborne et al. 1988; Calambokidis and Baird 1994; Johnson and Cassidy 1997; Osmek et al. 1998; Jeffries et al. 2000; Paulson 2003b; Jeffries 2006, personal communication; Laake 2006, personal communication; Carretta et al. 2007; Agness and Tannenbaum 2009b; WDFW 2013.

1. WDFW 2008c.

Table A-4. Amphibian and Reptile Species Known or Expected to Occur on NAVBASE Kitsap Bangor

Common Name	Scientific Name	Season(s) of Occurrence	Federal and State Listed Species		WDFW Priority Species? ¹
			Federal Status	Washington State Status	
Amphibians					
Northwestern salamander	<i>Ambystoma gracile</i>	year-round			
Long-toed salamander	<i>Ambystoma macrodactylum</i>	year-round			
Roughskin newt	<i>Taricha granulosa</i>	year-round			
Western red-backed salamander	<i>Plethodon vehiculum</i>	year-round			
Ensatina	<i>Ensatina escholtzii</i>	year-round			
Western toad	<i>Bufo boreas</i>	year-round	Species of concern	Candidate	X
Pacific treefrog	<i>Hyla regilla</i>	year-round			
Northern red-legged frog	<i>Rana aurora</i>	year-round			
Bullfrog (Non-native)	<i>Rana catesbeiana</i>	year-round			

Table A-4. Amphibian and Reptile Species Known or Expected to Occur on NAVBASE Kitsap Bangor (continued)

Common Name	Scientific Name	Season(s) of Occurrence	Federal and State Listed Species		WDFW Priority Species? ¹
			Federal Status	Washington State Status	
Reptiles					
Western painted turtle	<i>Chrysemys picta bellii</i>	year-round			
Slider (Introduced)	<i>Trachemys scripta</i>	year-round			
Northern alligator lizard	<i>Elgaria coerulea principis</i>	year-round			
Western fence lizard	<i>Sceloporus occidentalis</i>	year-round			
Rubber boa	<i>Charina bottae</i>	year-round			
Western terrestrial garter snake	<i>Thamnophis elegans</i>	year-round			
Northwestern garter snake	<i>Thamnophis ordinoides</i>	year-round			
Common garter snake	<i>Thamnophis sirtalis</i>	year-round			

Sources: Storm and Leonard 1995; Dvornich et al. 1997; Paulson 2003a; Jones et al. 2005; WDFW 2013.

1. WDFW 2008c.

LITERATURE CITED

- Agness, A. and B. Tannenbaum. 2009a. Naval Base Kitsap at Bangor Marine Bird Resource Report. Prepared by Science Applications International Corporation, Bothell, WA. Prepared for BAE Systems Applied Technologies, Inc., Rockville MD.
- Agness, A. and B. Tannenbaum. 2009b. Naval Base Kitsap at Bangor Marine Mammal Resource Report. Prepared by Science Applications International Corporation, Bothell, WA. Prepared for BAE Systems Applied Technologies, Inc., Rockville MD.
- Altman, B. 1999a. Conservation strategy for landbirds in coniferous forests of western Oregon and Washington, Version 1.0. Prepared for: Oregon-Washington Partners in Flight. 120 pp. http://www.orwapif.org/pdf/western_forest.pdf.
- Altman, B. 1999b. Conservation strategy for landbirds in lowlands and valleys of western Oregon and Washington, Version 1.0. Prepared for: Oregon-Washington Partners in Flight. 169 pages. http://www.orwapif.org/pdf/western_lowlands.pdf.
- Bhuthimethee, M., C. Hunt, G. Ruggerone, J. Nuwer, and W. Hafner. 2009. NAVBASE Kitsap Bangor Fish Presence and Habitat Use Phase III Field Survey Report 2007–2008. Prepared for BAE Systems Applied Technologies, Inc. Prepared by Science Applications International Corporation and Natural Resources Consultants.
- Calambokidis, J., and R.W. Baird. 1994. Status of marine mammals in the Strait of Georgia, Puget Sound, and the Juan de Fuca Strait, and potential human impacts. *Canadian Technical Report of Fisheries and Aquatic Sciences*. 1948: 282–300.
- Carretta, J.V., K.A. Forney, M.S. Lowry, J. Barlow, J. Baker, B. Hanson, and M.M. Muto. 2007. U.S. Pacific marine mammal stock assessment: December 2007. National Oceanic and Atmospheric Administration National Marine Fisheries Service. NOAA-TM-NMFS-SWFSC-414.
- Dvornich, K.M., K.R. McAllister, and K.B. Aubry. 1997. Amphibians and reptiles of Washington state: location data and predicted distributions, Vol. 2. In *Washington State Gap Analysis -- Final Report*, ed. Cassidy, K.M., C.E. Grue, M.R. Smith and K.M. Dvornich. Seattle, WA: Washington Cooperative Fish and Wildlife Research Unit, University of Washington. 146 pp.
- Jeffries, S. 2006. WDFW Marine Mammal Specialist. Personal communication with Alison Agness, SAIC, December 14, 2006, re: occurrence of marine mammals in Hood Canal.
- Jeffries, S.J., P.J. Gearin, H.R. Huber, D.L. Saul, and D.A. Pruett. 2000. Atlas of seal and sea lion haul-out sites in Washington. Washington Department of Fish and Wildlife, Wildlife Science Division, Olympia, WA. 150 pp. http://wdfw.wa.gov/wlm/research/papers/seal_haulout/.
- Johnson, R.E., and K.M. Cassidy. 1997. Terrestrial Mammals of Washington State: Location Data and Predicted Distributions. Volume 3 in Washington State Gap Analysis—Final Report (K.M. Cassidy, Fish and Wildlife Research Unit, University of Washington, Seattle.

- Jones, L.C., W.P. Leonard, and D.H. Olson, editors. 2005. *Amphibians of the Pacific Northwest*. Seattle Audubon Society, Seattle, WA. 226 pp.
- Kitsap Audubon Society. 2008. Kitsap Audubon Society Christmas Bird Counts, 2001–2007. Area 8: NAVBASE Kitsap Bangor. Data provided by Nancy Ladenberger, Area 8 Leader, Kitsap Audubon, Poulsbo, WA.
- Laake, J. 2006. Jeff Laake, Marine Mammal Specialist, National Marine Mammal Laboratory, NOAA Sandpoint, Seattle, WA. December 19, 2006. Personal communication with Alison Agness, Marine Biologist, Science Applications International Corporation, Bothell, WA, re: occurrence of marine mammals in Hood Canal.
- Nysewander, D.R., J.R. Evenson, B.L. Murphie, and T.A. Cyra. 2005. Report of marine bird and marine mammal component, Puget Sound ambient monitoring program, for July 1992 to December 1999 period. Prepared for the Washington State Department of Fish and Wildlife and Puget Sound Action Team. Washington State Department of Fish and Wildlife, Wildlife Management Program, Olympia, WA. January 31, 2005.
- Opperman, H. 2003. *A birder's guide to Washington*. American Birding Association: Colorado Springs, CO.
- Osborne, R., J. Calambokidis, and E.M. Dorsey. 1988. *A guide to marine mammals of Greater Puget Sound*. Anacortes, WA: Island Publishers.
- Osmek, S.D., J. Calambokidis, and J.L. Laake. 1998. Abundance and Distribution of Porpoise and Other Marine Mammals of the Inside Waters of Washington and British Columbia. 1998 Puget Sound Research Conference Proceedings. Olympia, WA.
- Palsson, W.A. 2007. Wayne A. Palsson, Research scientist, Washington State Department of Fish and Wildlife, July 10, 2007. Personal communication, e-mail to Mary Bhuthimethee, SAIC, re: fish species in Hood Canal.
- Paulson, D. 2003a. Amphibians and Reptiles of Washington. In *A Birder's Guide to Washington*, ed. H. Opperman. Colorado Springs: American Birding Association. 598–600.
- Paulson, D. 2003b. Mammals of Washington. In *A Birder's Guide to Washington*, ed. H. Opperman. Colorado Springs: American Birding Association. 593–597.
- Puget Sound Action Team. 2007. 2007 Puget Sound Update: Ninth Report of the Puget Sound Assessment and Monitoring Program. Puget Sound Action Team. Olympia, WA. 260 pp.
- Reef Environmental Education Foundation (REEF). 2008. REEF Fish Project Survey Data for Hood Canal. Accessed February 2008.
- SAIC. 2006. Fish Presence and Habitat Use, Combined Phase I and II Field Survey Report. Prepared by Science Applications International Corporation, Bothell, WA. Prepared for BAE Systems Applied Technologies, Inc., Rockville MD.

Storm, R.M., and W.P. Leonard, coordinating editors. 1995. *Reptiles of Washington and Oregon*. Seattle Audubon Society, Seattle, WA. September 1995. 176 pp.

Taber, R.D., and K.J. Raedeke. 1983. Deer and game bird studies, SUBASE Bangor. Subproject 2. Game birds. Contract Number: N00406-82-M-C646. Code N86, Naval Submarine Base, Bangor, Bremerton, WA. 12 pp.

University of Washington. 2000. Big Beef Creek Field Station Program Plan—A Working Draft. Karen Schmitt, Program Manager, College of Ocean and Fishery Sciences. <http://online.caup.washington.edu/courses/LarcSP00/Larc523/BBCPlan523.doc.html>.

U.S. Fish and Wildlife Service (USFWS). 2008. Birds of conservation concern 2008. USFWS Division of Migratory Bird Management, Arlington, VA. <http://www.fws.gov/migratorybirds/NewReportsPublications/SpecialTopics/BCC2008/BCC2008.pdf>.

Wahl, T.R., B. Tweit, S.G. Mlodinow. 2005. *Birds of Washington*. Oregon State University Press, Corvallis, WA.

Washington Department of Fish and Wildlife (WDFW). 2008a. *Marine Protected Areas in Puget Sound - Sund Rock Conservation Area*. http://www.wdfw.wa.gov/fish/mpa/puget_sound/08sr.htm (Accessed February 7, 2008).

WDFW. 2008b. *Marine Protected Areas in Puget Sound - Octopus Hole Conservation Area*. http://www.wdfw.wa.gov/fish/mpa/puget_sound/08oh.htm (Accessed February 7, 2008).

WDFW. 2008c. Priority habitat and species list. Olympia, WA. 174 pp.

WDFW. 2013. *Washington State Species of Concern Lists*, Olympia, WA. <http://wdfw.wa.gov/conservation/endangered/All/> (Accessed April 1, 2013).

APPENDIX B

MARINE FISH LIFE HISTORY, HABITAT CONDITIONS, AND HEARING

TABLE OF CONTENTS

APPENDIX B.....	B-1
1.0 MARINE FISH LIFE HISTORIES.....	B-1
1.1. ESA-LISTED SALMONIDS	B-1
1.1.1. Puget Sound Chinook.....	B-1
1.1.1.1. Status	B-1
1.1.1.2. Life History.....	B-1
1.1.1.3. Occurrence	B-2
1.1.2. Hood Canal Summer-run Chum Salmon.....	B-4
1.1.2.1. Status	B-4
1.1.2.2. Life History.....	B-5
1.1.2.3. Occurrence	B-5
1.1.3. Puget Sound Steelhead	B-7
1.1.3.1. Status	B-7
1.1.3.2. Life History.....	B-7
1.1.3.3. Occurrence	B-8
Winter-run.....	B-8
Summer-run	B-9
1.1.4. Bull Trout.....	B-9
1.1.4.1. Status	B-9
1.1.4.2. Life History.....	B-9
1.1.4.3. Occurrence	B-10
1.2. ESA-LISTED ROCKFISH.....	B-10
1.2.1. Bocaccio.....	B-10
1.2.1.1. Status	B-10
1.2.1.2. Life History.....	B-11
1.2.1.3. Occurrence	B-11
1.2.2. Canary Rockfish.....	B-11
1.2.2.1. Status	B-11
1.2.2.2. Life History.....	B-11
1.2.2.3. Occurrence	B-12
1.2.3. Yelloweye Rockfish.....	B-12
1.2.3.1. Status	B-12
1.2.3.2. Life History.....	B-12
1.2.3.3. Occurrence	B-13
1.3. NON-ESA-LISTED SALMONIDS	B-13
1.3.1. Chum Salmon (Fall-run and Hatchery Fish)	B-13
1.3.1.1. Life History.....	B-13
1.3.1.2. Occurrence	B-13
1.3.2. Coho Salmon.....	B-14
1.3.2.1. Life History.....	B-14
1.3.2.2. Occurrence	B-14
1.3.3. Pink Salmon	B-14
1.3.3.1. Life History.....	B-14
1.3.3.2. Occurrence	B-15
1.3.4. Cutthroat Trout.....	B-15
1.3.4.1. Life History.....	B-15
1.3.4.2. Occurrence	B-15
1.3.5. Sockeye Salmon	B-16
1.4. FORAGE FISH.....	B-16
1.4.1. Pacific Herring	B-16
1.4.1.1. Life History.....	B-16
1.4.1.2. Occurrence	B-16
Occurrence at LWI Project Sites.....	B-17
Occurrence at the SPE Project Site	B-17
1.4.2. Surf Smelt	B-17
1.4.2.1. Life History.....	B-17

1.4.2.2.	Occurrence.....	B-18
	Occurrence at LWI Project Sites.....	B-18
	Occurrence at SPE Project Sites	B-18
1.4.3.	Pacific Sand Lance	B-19
1.4.3.1.	Life History	B-19
1.4.3.2.	Occurrence.....	B-20
	Occurrence at LWI Project Sites.....	B-20
	Occurrence at SPE Project Sites	B-20
2.0 HABITAT CONDITIONS		B-20
2.1.	WATER AND SEDIMENT QUALITY.....	B-21
2.1.1.	Water and Sediment Quality at the LWI Project Sites	B-21
2.1.2.	Water and Sediment Quality at the SPE Project Site.....	B-21
2.2.	PHYSICAL HABITAT AND BARRIERS	B-22
2.2.1.	Physical Habitat and Barriers at the LWI Project Sites	B-22
2.2.2.	Physical Habitat and Barriers at the SPE Project Site	B-23
2.3.	BIOLOGICAL HABITAT	B-23
2.3.1.	Prey Availability.....	B-23
2.3.1.1.	Prey Availability at the LWI Project Sites.....	B-23
2.3.1.2.	Prey Availability at the SPE Project Site	B-23
2.3.2.	Aquatic Vegetation.....	B-24
2.3.2.1.	Aquatic Vegetation at the LWI Project Sites	B-24
2.3.2.2.	Aquatic Vegetation at the SPE Project Site	B-24
2.4.	UNDERWATER NOISE.....	B-24
3.0 FISH HEARING AND RESPONSE TO UNDERWATER SOUND		B-25
3.1.	PHYSIOLOGICAL RESPONSES	B-25
3.2.	BEHAVIORAL RESPONSES	B-26
4.0 LITERATURE CITED		B-29

LIST OF FIGURES

Figure B-1. Salmonids, in Order of Abundance, Captured During 2005–2008 Bangor Beach Seine Surveys.....	B-3
---	-----

LIST OF TABLES

Table B-1. Spawning Period Timing and Peak of Adult Hood Canal Stocks of Puget Sound Chinook	B-2
Table B-2. Timing of Puget Sound Chinook Juvenile Presence and Out-migration on NAVBASE Kitsap Bangor	B-3
Table B-3. Timing of Hood Canal Summer-run Chum Juvenile Presence and Out-migration in Hood Canal and along the Bangor Shoreline	B-5
Table B-4. Spawning Period, Peak, and 90-Percent Spawning Timing of Adult Stocks of Hood Canal Summer-run Chum.....	B-6
Table B-5. Migration, Spawning Period, and Peak of Winter-run Stocks of Puget Sound Steelhead.....	B-9

1.0 MARINE FISH LIFE HISTORIES

1.1. ESA-LISTED SALMONIDS

1.1.1. Puget Sound Chinook

1.1.1.1. STATUS

The Puget Sound Chinook salmon evolutionarily significant unit (ESU) was listed as federally threatened under the Endangered Species Act (ESA) in 1999 (64 Federal Register [FR] 14308), with the threatened listing reaffirmed in 2005 (70 FR 37160). Critical habitat was designated for Puget Sound Chinook in 2005 (70 FR 52685). In 2002, average adult Chinook escapement (number of fish surviving to reach spawning grounds or hatcheries) was relatively low, particularly for the mid-Hood Canal stock, for which average escapements were typically below the low escapement threshold of 400 Chinook fish (Washington Department of Fish and Wildlife [WDFW] 2002). In the most recent 5-Year Review, NMFS found that while natural origin recruit escapements have remained fairly constant from 1985–2009, total natural origin recruit abundance and productivity have continued to decline (NMFS 2011).

This Puget Sound Chinook ESU comprises all naturally spawned populations of Chinook salmon from rivers and streams flowing into Hood Canal, and includes 26 artificial propagation programs in Puget Sound, such as the Hamma Hamma and George Adams hatcheries. Within mid-Hood Canal, the Big Beef Creek Chinook salmon hatchery was terminated from this program, with the last of the adults returning to spawn in 2008 (NMFS 2011). Two populations of Chinook, the Mid-Hood Canal population and the Skokomish River population, are included in the ESA-listed Distinct Population Segment (DPS) within Hood Canal drainages, and are considered essential to the recovery of the species.

All Puget Sound Chinook salmon populations are considered well below escapement abundance levels identified as required for recovery to low extinction risk in the recovery plan (NMFS 2011). NMFS (2011) stated that the updated information on abundance, productivity, spatial structure and diversity since the last review does not indicate a change in this ESU's biological risk category. Although a review of 1999–2008 returning spawning abundance data indicated neither of the Hood Canal populations displayed an increasing or decreasing trend in population abundance (NWFSC 2013), these criteria for the ESU overall are in decline (NMFS 2011).

Since the listing of Puget Sound Chinook, reduced viability of these specific stocks was attributed to habitat loss and degradation, hatcheries, and harvest management issues. Additionally, dissolved oxygen (DO) levels in portions of Hood Canal are at a historic low, which is a concern and future threat to recovery of the Hood Canal stocks of this and all other Hood Canal salmonid ESUs (70 FR 76445). DO levels at the waterfront of Naval Base (NAVBASE) Kitsap Bangor are discussed in Section 3.1.1.1.2.

1.1.1.2. LIFE HISTORY

Chinook salmon (*Oncorhynchus tshawytscha*) is the largest of the *Oncorhynchus* species, typically reaching 8 to 10 kg, although Chinook salmon have been documented in excess of 45 kg (Healey 1991; Quinn 2005). Resident Puget Sound Chinook salmon, however, are

typically on the smaller end of this scale. Due to their relatively large size, Chinook salmon generally spawn in larger rivers or streams than other salmonids (Healey 1991; Quinn 2005). Chinook salmon can be highly variable between and within given watersheds. They have various in-migration (e.g., spring versus fall) and out-migration (e.g., ocean-type versus stream-type) times that can vary within a given system, stock, or run of fish (WDFW 2002; Healey 1991; Myers et al. 1998; Duffy 2003, 2009; Duffy et al. 2005; Redman et al. 2005; Quinn 2005).

Emergent Chinook fry, like fry of other Pacific salmonids, depend on shaded, nearshore freshwater habitat, with slow-moving currents, where they forage on drift organisms, including insects and zooplankton (Healey 1991). In general, ocean-type parr (the freshwater stage of juvenile salmon, which usually occurs in the first one to two years of life) usually migrate to estuarine areas from April through July with some variability (peak out-migration occurring from May to early July), becoming smolts (juveniles that have transitioned from fresh water to salt water) soon after entering marine waters. Duffy et al. (2005) found that wild ocean-type Chinook out-migrate to Puget Sound waters from March to July, while hatchery Chinook occupy nearshore Puget Sound waters soon after release and in pulses from May to June. Once reaching the marine environment, they then spend a few weeks or longer rearing in the estuary (Duffy 2003, 2009; Duffy et al. 2005).

Table B-1 provides detailed information regarding the in-migration and spawn timing of adult Puget Sound Chinook past NAVBASE Kitsap Bangor, and within the greater Hood Canal region. Adult Chinook salmon enter Hood Canal waters from August to October to begin spawning in their natal streams in September, with peak spawning in October.

Table B-1. Spawn Period Timing and Peak of Adult Hood Canal Stocks of Puget Sound Chinook

Stock	Time period detected in Hood Canal	Spawn time period	Spawn peak
Skokomish stock	Late-August to October	Mid-September to October	Mid-October
Mid-Hood Canal stock	Mid-August to late October	Early September to late October	October

Source: Healey 1991

1.1.1.3. OCCURRENCE

Chinook salmon are one of the least abundant salmonids occurring along the Bangor shoreline (Figure B-1). From 2005 to 2008, a total of 58,667 salmonids were captured in beach seine surveys along the Bangor waterfront (SAIC 2006; Bhuthimethee et al. 2009). During that time period, only 224 of the total number of salmonids captured (approximately 0.4 percent) were juvenile Chinook salmon (Figure B-1).

Offshore tow-netting and beach seine surveys during the 1970s (Schreiner et al. 1977; Prinslow et al. 1980; Bax 1983; Salo 1991), and nearshore beach seine surveys from 2005–2008 (Science Applications International Corporation [SAIC] 2006; Bhuthimethee et al. 2009), determined that Chinook salmon migrating from southern Hood Canal streams and hatcheries occur most frequently along the Bangor waterfront from late May to early July (Table B-2). These studies indicate that peak occurrence in these waters generally occurs from as early as May to as late as July (Table B-2). More recent tagging investigations have shown that juvenile Chinook

distribution and movement patterns are not well known (Chamberlin et al. 2011). Juvenile Chinook salmon may have extended intrabasin residence times and utilize these habitats for extended rearing periods, not specifically as a nearshore migratory corridor.

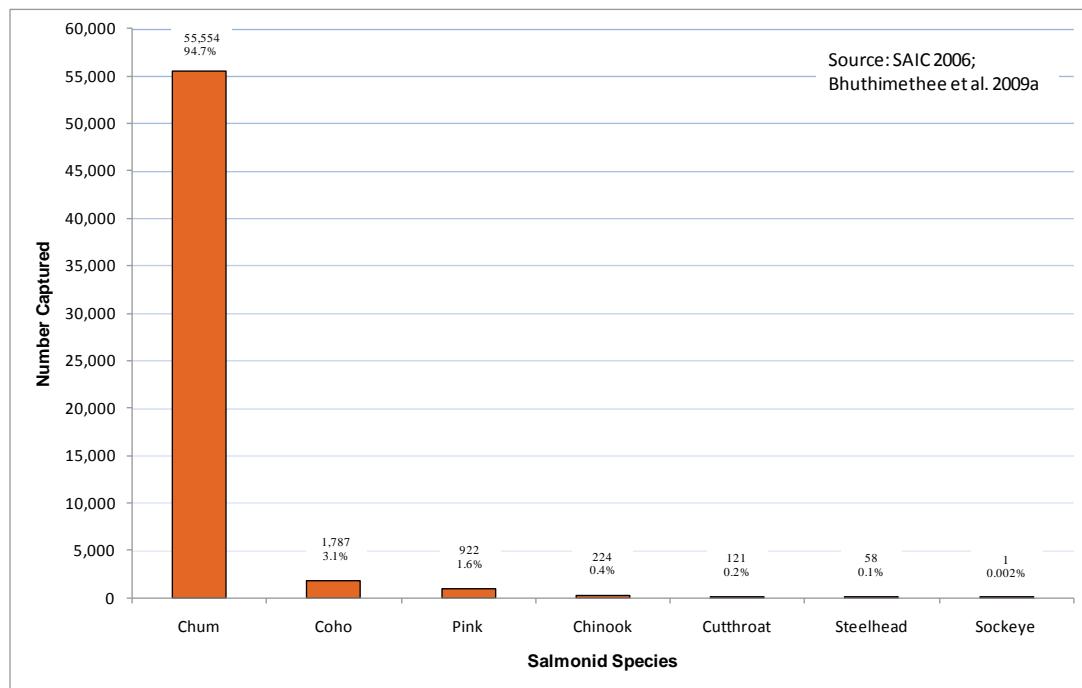


Figure B–1. Salmonids, in Order of Abundance, Captured During 2005–2008 Bangor Beach Seine Surveys

Table B–2. Timing of Puget Sound Chinook Juvenile Presence and Out-migration on NAVBASE Kitsap Bangor

Reference	Time period detected in Hood Canal	Peak out-migration timing
Bax et al. 1978; Bax et al. 1980	February to July	May to early June
Schreiner 1977	May to July	Late June to early July
SAIC 2006	April to September	Mid-June to late June

In an effort to clarify the timing of juvenile salmonid arrival to mid-Hood Canal estuaries, a number of joint investigations by state and federal resource agencies and non-governmental entities were conducted. The findings in Hood Canal tributaries indicated slightly earlier arrivals to the lower portions of these drainages (Weinheimer 2013). Screw traps were deployed from January to July 2012 to capture juvenile salmonids within the lowest 0.5 mile of the Duckabush and Hamma Hamma Rivers. Findings showed that chum arrived as early as January. Within the Duckabush, results indicated the migration reached a median point in April and was 95 percent complete by the first week of June. Within the Hamma Hamma, results indicated the migration reached a median point in March and was 95 percent complete by April 10.

1.1.2. Hood Canal Summer-run Chum Salmon

1.1.2.1. STATUS

The Hood Canal summer-run chum salmon ESU was federally listed as threatened under the ESA in 1999, and the threatened listing was reaffirmed in 2005 (70 FR 37160) (Table B-1). Two populations of Hood Canal summer-run chum salmon within Hood Canal are considered essential to the recovery of the species. In a review of returning spawners data for this ESU through 2007, NWFSC indicated the populations were displaying an increasing trend, with Strait of Juan de Fuca populations increasing at a slightly higher rate than Hood Canal populations (NWFSC 2013). Critical habitat was also designated for Hood Canal summer-run chum ESU in 2005, and the National Marine Fisheries Services (NMFS) recovery plan for this species was adopted on May 24, 2007 (72 FR 29121).

Historically, there were sixteen stocks within the Hood Canal summer-run chum ESU, eight of which are extant (six in Hood Canal and two in the eastern Strait of Juan de Fuca) with the remaining eight extinct (71 FR 47180). Six current summer chum stocks have been identified in Hood Canal: Quilcene, Dosewallips, Duckabush, Hamma Hamma, Lilliwaup, and Union (NMFS 2011). Six additional stocks were identified as recent extinctions: Skokomish, Finch, Tahuya, Dewatto, Anderson, and Big Beef.

The Hood Canal summer-run chum salmon ESU includes all naturally spawned populations of summer-run chum salmon in Hood Canal and its tributaries, as well as populations in Olympic Peninsula rivers between Hood Canal and Dungeness Bay, Washington, and eight artificial propagation programs: Quilcene NFH, Hamma Hamma Fish Hatchery, Lilliwaup Creek Fish Hatchery, Union River/Tahuya, Big Beef Creek Fish Hatchery, Salmon Creek Fish Hatchery, Chimacum Creek Fish Hatchery, and the Jimmycomelately Creek Fish Hatchery summer-run chum hatchery programs (NMFS 2011). However, five Hood Canal summer chum hatchery programs were terminated since the last status review, including: Quilcene National Fish Hatchery, Union River/Tahuya River, Big Beef Creek, Salmon Creek, and Chimacum Creek programs. The last adult fish produced through these terminated programs returned in 2008 (NMFS 2011).

Based on the most recent 5-Year Review, NMFS (2011) found that the overall trend in spawning abundance is generally stable for the Hood Canal population (all natural spawners and natural-origin only spawners) and for the Strait of Juan de Fuca population (all natural spawners). Only the Strait of Juan de Fuca population's natural-origin spawners show a significant positive trend. Productivity from 2005 to 2009 was very low, especially compared to the relatively high productivity observed from 1994 to 2004.

Reduced viability, lower survival, and listing of extant stocks of summer-run chum and recent stock extinctions in Hood Canal are attributed to the combined impacts of three primary factors: (1) habitat loss and degradation, (2) climate change, and (3) increased fishery harvest rates (Hood Canal Coordinating Council [HCCC] 2005). An additional factor cited in WDFW and Point No Point Treaty Tribes (PNPTT) (2000) and HCCC (2005) was impacts associated with the releases of hatchery salmonids, which compete with naturally spawning stocks for food and other resources.

1.1.2.2. LIFE HISTORY

Chum salmon (*Oncorhynchus keta*) have the broadest distribution of all salmonid species (Pauley et al. 1988) and range along the Northeast Pacific coast from Monterey Bay, California, to the Arctic Ocean (Pauley et al. 1988; Salo 1991; Johnson et al. 1997). Chum salmon generally live 3 to 5 years and are relatively large compared to other salmonids, second only to Chinook. Similar to pink salmon, adult chum salmon prefer to spawn in the lower reaches of their natal streams (Pauley et al. 1988; Tynan 1997; Quinn 2005). Summer-run adults typically migrate from marine waters into Hood Canal from early August through the end of September (Tynan 1997). Summer-run adult salmon typically migrate from the marine waters to spawning grounds from early September through mid-October (Tynan 1997).

Female chum salmon lay between 900 and 8,000 eggs (Pauley et al. 1988) that are extremely sensitive to changes in the environment, with a high degree of mortality (up to 90 percent) in the developing eggs (Pauley et al. 1988). Emerging fry spend only a few days to a few weeks rearing in fresh water before migrating toward marine habitats from March to May (Pauley et al. 1988; Salo 1991; Johnson et al. 1997; Quinn 2005). While in this environment, chum fry stay in very shallow, nearshore habitats and consume a number of epibenthic invertebrates, including gammaridean amphipods, harpacticoid copepods, cumaceans, and mysids (Pauley et al. 1988). Chum salmon utilize estuarine habitats for a few more weeks before migrating to coastal, then offshore waters.

During out-migration, fry move within the nearshore corridor and into and out of sub-estuaries with the tides, most likely in search of food resources (Hirschi et al. 2003). At a migration rate of 4.4 miles per day, the majority of chum emigrants from southern Hood Canal exit the canal to the north 14 days after their initial emergence in seawater (WDFW and PNPTT 2000).

Table B-3 provides a summary of the presence and out-migration timing of juvenile summer-run chum from Hood Canal. Juvenile summer-run chum are expected to occur near the proposed project areas from late January through early June.

Table B-3. Timing of Hood Canal Summer-run Chum Juvenile Presence and Out-migration in Hood Canal and along the Bangor Shoreline

Reference	Sampling Location(s)	Time Period Detected in Hood Canal	Peak Out-migration Timing on NAVBASE Kitsap Bangor
Prinslow et al. 1980; Salo et al. 1980; Bax 1983	NAVBASE Kitsap Bangor	February to March	March
WDFW and PNPTT 2000	Estimated emergence from Hood Canal	February to late May	Late March
SAIC 2006	NAVBASE Kitsap Bangor	Late January through early June	Late March

1.1.2.3. OCCURRENCE

Beach seine surveys were conducted along the Bangor Bangor waterfront from 2005 to 2008 (SAIC 2006; Bhuthimethee et al. 2009). During that time, 55,554 out of 58,667 total salmonids captured (approximately 94.7 percent) were juvenile chum salmon (Figure B-1). Chum salmon peak abundance along the NAVBASE Kitsap Bangor shoreline generally peaks in late April to

early May (Bhuthimethee et al. 2009). However, this peak abundance is strongly influenced by hatchery releases. In 2007, Hood Canal hatcheries released approximately 26 million juvenile chum salmon (Bhuthimethee et al. 2009). Release dates varied from February to May, although at least 23 million of these fish were released from April 1 to April 20. However, because they are visually indistinguishable at smaller sizes, no distinction in the field could be made between hatchery-produced fish and naturally produced (“wild”) fish. To gain a better understanding of natural production of these stocks, studies need to be conducted in freshwater systems, away from the influences of hatchery releases.

To observe juvenile salmon out-migration away from the influence of hatcheries, Weinheimer (2013) deployed screw traps from January to July 2012 within the lowest 0.5 mile of the Duckabush and Hamma Hamma Rivers. The estuaries for these two systems are located approximately 12 and 17 miles, respectively, south of NAVBASE Kitsap Bangor. Weinheimer (2013) reported that chum salmon were present in both screw traps in January. Similar to comparing hatchery-produced fish to naturally produced fish, they are visually indistinguishable at smaller sizes, so no distinction in the field could be made between fall-run chum and summer-run chum salmon. Within the Duckabush, findings indicated the migration reached a median point in mid-March, and was 95 percent complete by the first week of April. Within the Hamma Hamma, findings indicated the migration reached a median point in mid-March, and was 95 percent complete by April 9. Genetic studies differentiating fall-run and summer-run chum salmon found that summer-run fish comprised over 90 percent of all chum captured in the Duckabush from January through the first week of April. Within the Hamma Hamma trap, summer-run chum comprised over 90 percent of all chum captured from January through mid-March (Weinheimer 2013).

Summer-run chum adults return to Hood Canal from as early as August and September through the first week in October (Washington Department of Fisheries et al. 1993; WDFW and PNPTT 2000). Approximately one month separates peak spawn timing of the early (summer) and later (fall) runs of chum salmon in Hood Canal (Johnson et al. 1997; Table B-4).

Table B-4. Spawning Period, Peak, and 90-Percent Spawn Timing of Adult Stocks of Hood Canal Summer-run Chum

Stock	Time Period Detected in Hood Canal ¹	Spawn Time Period and Peak	Date at which 90 Percent of Spawning is Complete
Big/Little Quilcene	Early September to Mid-October	Mid-September to Mid-October	10/1 to 10/5
Lilliwaup Creek	Early September to Mid-October	Mid-September to Mid-October	10/10
Hamma Hamma	Early September to Mid-October	Mid-September to Mid-October	10/8 to 10/10
Duckabush	Early September to Mid-October	Mid-September to Mid-October	10/11
Dosewalips	Early September to Mid-October	Mid-September to Mid-October	10/9
Union	Mid-August to Early October	Early September to Early October	9/29 to 9/30

Sources: WDFW 2002; WDFW and PNPTT 2000.

1. Range of timing estimates from WDFW and PNPTT, in Appendix Report 1.2 (WDFW and PNPTT 2000).

1.1.3. Puget Sound Steelhead

1.1.3.1. STATUS

The Puget Sound steelhead was listed in May 2007 under the ESA as a threatened distinct population segment (DPS) (72 FR 26722). In January 2013 NMFS proposed critical habitat for Puget Sound steelhead (78 FR 2726). Stocks of the Puget Sound steelhead DPS are mainly winter-run, although a few small stocks of summer-run steelhead also occur (71 FR 15666). Eight stocks of winter-run and three stocks of summer-run Puget Sound steelhead occur in Hood Canal (WDFW 2002). Some stocks of Puget Sound steelhead in Hood Canal (i.e., hatchery supplementation or hatchery releases to non-native streams) may not be considered part of the DPS (71 FR 15668).

The origin and production type of all stocks of Puget Sound steelhead occurring in Hood Canal remain unresolved by the state and tribes (WDFW 2002). The 1996 status review (Busby et al. 1996) and more recent NMFS review for Puget Sound steelhead (Hard et al. 2007) included only three stocks of winter-run steelhead that occur in Hood Canal as native populations: (1) Tahuya winter steelhead, (2) Dewatto winter steelhead, and (3) Skokomish winter steelhead. Official determination for the proposed DPS listing has not been designated, and specifics on all stocks to be included in the DPS listing are forthcoming. In general, abundance of winter-run steelhead stocks in Hood Canal has been low, with most stocks averaging less than 200 adult spawners per year (NMFS 2005a). The status of the listed Puget Sound steelhead DPS has not changed substantially since the 2007 listing. Most populations within the DPS are showing continued downward trends in estimated abundance, some steeply.

The DPS includes all naturally spawned anadromous winter-run and summer-run *O. mykiss* (steelhead) populations, in streams in the river basins of the Strait of Juan de Fuca, Puget Sound, and Hood Canal, Washington, bounded to the west by the Elwha River (inclusive) and to the north by the Nooksack River and Dakota Creek (inclusive), as well as the Green River natural and Hamma Hamma winter-run steelhead hatchery stocks (NMFS 2011). The Hamma Hamma River hatchery program and four other hatchery programs are not considered part of the DPS, with a number of hatchery supplementation programs terminated in the last 10 years. As a result, steelhead supplementation in the Hamma Hamma was discontinued, with the last returning adult steelhead arriving in 2010 (NMFS 2011). Five new steelhead programs propagating native-origin fish for the purposes of preserving and recovering the populations also have been initiated. These programs support recovery of native winter-run steelhead in the White, Dewatto, Duckabush, North Fork Skokomish, and Elwha River watersheds. The new programs warrant consideration for inclusion in the DPS (NMFS 2011).

Freshwater habitat degradation and fragmentation, with consequent effects on connectivity, are among the primary limiting factors and threats facing the Puget Sound steelhead DPS (NMFS 2011). Despite ongoing efforts by multiple parties to improve habitat conditions in Puget Sound, habitat in all ESUs and DPS remains far below that needed to sustain viable populations of listed fish (NMFS 2011). The critical habitat proposed to protect this species places an emphasis on freshwater habitats (78 FR 2726).

1.1.3.2. LIFE HISTORY

Steelhead exhibit the most complex life history of any species of Pacific salmon. Steelhead can be freshwater residents (referred to as rainbow trout) or anadromous (referred to as steelhead),

and, under some circumstances, they can yield offspring of the alternate life history form (72 FR 26722). Anadromous forms can spend up to seven years in fresh water prior to smoltification and then spend up to three years in salt water prior to migrating back to their natal streams to spawn (Busby et al. 1996). In addition, steelhead can spawn up to four times and have been documented to live as long as 8 or 9 years (Pauley et al. 1986), whereas other Pacific salmon species generally spawn once and die. Because steelhead grow larger in the productive marine environment, fish that stay in these habitats longer are typically larger. Studies investigating this have found that steelhead range in size from 47 cm (18.5 inches) for a 1-year saltwater resident to 88 cm (34.6 inches) for a 4-year saltwater resident (Maher and Larkin 1954, as cited in Pauley et al. 1986). Steelhead are prevalent throughout streams and tributaries of Puget Sound (Pauley et al. 1986). Both winter and summer steelhead types, or races, occur within Washington State streams and rivers.

Typically adult steelhead return to streams and rivers in the winter or summer and spawn in the spring and summer, with fry emerging in just a few weeks. Upon emergence, steelhead typically rear in the freshwater streams and rivers between 1 and 3 years. Following their downstream migration to marine waters, these fish rear and mature in the ocean for 1 to 3 years before returning to freshwater systems as adults to spawn (Pauley et al. 1989; Quinn 2005). Because steelhead can be repeat spawners, the age and size of returning adults varies considerably.

1.1.3.3. OCCURRENCE

Limited information is available regarding the timing of juvenile out-migration for winter-run steelhead in Hood Canal. WDFW suggests that juvenile out-migration of steelhead stocks in Hood Canal occurs from March through June, with peak out-migration during April and May (Johnson 2006, personal communication). Beach seine surveys from 2005 to 2008 did not catch large numbers of steelhead along the Bangor shoreline (Figure B-1). Steelhead captured during these shoreline surveys occurred most frequently in the late spring and early summer months. A total of 58,667 salmonids were captured in these beach seine surveys (SAIC 2006; Bhuthimethee et al. 2009). During that time period, only 58 of the total number of salmonids captured (approximately 0.1 percent) were juvenile steelhead (Figure B-1). The absence of juvenile steelhead from nearshore surveys is largely due to these juveniles occurring as smolts, much larger than the chum and pink salmon fry that occur along the shoreline. As juvenile steelhead enter nearshore marine waters as smolts, they are already at a size and developmental stage to move further offshore to forage on larger prey items. In the 2013 proposed critical habitat notification, studies reviewed by NMFS indicated that “steelhead migratory behavior strongly suggests that juveniles spend little time (a matter of hours in some cases) in estuarine and nearshore areas and do not favor migration along shorelines” (78 FR 2726).

WINTER-RUN

Most stocks of winter-run steelhead in Hood Canal (Skokomish, Hamma Hamma, Duckabush, Quilcene/Dabob Bay, and Dosewallips) spawn from mid-February to mid-June (WDFW 2002; Table B-5). Information published to date indicates adult spawn timing occurs from mid-February to early June.

SUMMER-RUN

Information on the timing of juvenile out-migration for summer-run steelhead in Hood Canal is not currently available. Spawn timing of summer-run steelhead in Hood Canal is not fully understood; however, spawning is believed to occur from February through April (WDFW 2002).

Table B–5. Migration, Spawning Period, and Peak of Winter-run Stocks of Puget Sound Steelhead

Stock	Time Period Detected in Hood Canal ¹	Spawn Time Period ²	Peak Spawning
Tahuya winter-run	January through June	Early March to early June	May
Skokomish winter-run	January through mid-July	Mid-February to mid-June	May
Dewatto winter-run	January through June	Mid-February to early June	May
Union winter-run	Not identified	Mid-February to early June	Not identified
Hamma Hamma winter-run	Not identified	Mid-February to early June	Not identified
Duckabush winter-run	Not identified	Mid-February to early June	Not identified
Quilcene/Dabob Bay winter-run	Not identified	Mid-February to early June	Not identified
Dosewallips winter-run	Not identified	Mid-February to early June	Not identified

1. Time period detected in Hood Canal, reported in Busby et al. (1996).

2. Spawn timing reported in WDFW (2002).

1.1.4. Bull Trout

1.1.4.1. STATUS

Currently, all populations of bull trout in the lower 48 states are listed as threatened under the ESA. Bull trout are in the char subgroup of salmonids and have both resident and migratory life histories (64 FR 58910). The Coastal-Puget Sound bull trout DPS reportedly contains the only occurrence of anadromous bull trout in the contiguous United States (64 FR 58912); Hood Canal is one of five geographically distinct regions within this DPS. All Hood Canal bull trout originate in the Skokomish River (WDFW 2004). Critical habitat was originally designated for bull trout in 2005 (70 FR 56212) with a final revision to this habitat published in 2010 (75 FR 63898).

1.1.4.2. LIFE HISTORY

The food sources used by bull trout vary by life form, but in general they are considered opportunistic feeders (64 FR 58911). Both the resident and juvenile forms forage on aquatic and terrestrial insects, macro zooplankton, amphipods, mysids, crayfish, and small fish, whereas adult migratory bull trout primarily consume fish, including trout and salmon species, whitefish, yellow perch, and sculpin (64 FR 58911).

Resident bull trout remain in freshwater streams for their entire life cycle, whereas migratory bull trout, which have the potential to occur along the Bangor shoreline, spawn and rear in streams but migrate to marine waters as juveniles (64 FR 58910). Little information is known about the anadromous life history of this species. The spawning and early juvenile habitat requirements of bull trout are more specific than other salmonids, which may explain their patchy distribution (64 FR 58910). Important habitat features relevant to marine waters include cold water temperature (40 to 48°F), cover/shading, and intact migratory corridors (64 FR 58910). Reasons for declines and listing include habitat loss, degradation, and fragmentation; blocked migratory corridors (by dams or construction); introduced fish species (lake trout, brook trout, brown trout, and hatchery rainbow trout); and incidental harvest (64 FR 58910).

Bull trout in the Skokomish River system are thought to spawn from mid-September to December (WDFW 2004). It is not likely that bull trout migrate through the Bangor waterfront and past the Land-Water Interface (LWI) or Service Pier Extension (SPE) project sites (U.S. Fish and Wildlife Service [USFWS] 2010). For the species as a whole, emergence of fry occurs from early April to May (64 FR 58910).

1.1.4.3. OCCURRENCE

Neither historic nor recent juvenile fish surveys (using beach and lampara seines and tow nets) have captured bull trout (Schreiner et al. 1977; Salo et al. 1980; Bax 1983; SAIC 2006; Bhuthimethee et al. 2009). Not enough is known to fully describe the duration of juvenile out-migration for bull trout in Hood Canal (WDFW 2004).

1.2. ESA-LISTED ROCKFISH

1.2.1. Bocaccio

1.2.1.1. STATUS

Puget Sound bocaccio, a species of rockfish, were federally listed as endangered under the ESA in 2010 (75 FR 22276). Critical habitat for yelloweye rockfish, canary rockfish, and bocaccio of the Puget Sound Georgia Basin was designated in November 2014 (79 FR 68042). WDFW published a revised draft environmental impact statement titled *Puget Sound Rockfish Conservation Plan* on April 6, 2010 (Bargmann et al. 2010). Threats to rockfish in Puget Sound include areas of low DO, commercial and sport fisheries (notably mortality associated with fishery bycatch), reduction of kelp habitat necessary for juvenile recruitment (74 FR 18516), habitat disruption (including exotic species), derelict gear (notably lost or abandoned fishing nets), climate changes, species interactions (including predation and competition), diseases, and genetic changes (Palsson et al. 2009; Drake et al. 2010).

Although rockfish are typically long-lived, recruitment is generally poor as larval survival and settlement depend on a variety of factors including marine currents, adult abundance, habitat availability, and predator abundance (Palsson et al. 2009; Drake et al. 2010). The combination of these factors has contributed to declines in the species within Georgia Basin and Puget Sound in the last few decades (74 FR 18516).

1.2.1.2. LIFE HISTORY

Bocaccio range from Punta Blanca, Baja California, to the Gulf of Alaska, Alaska (Love et al. 2002). They are believed to have commonly occurred in steep-walled habitats in most of Puget Sound prior to fishery exploitations, although they are currently very rare in the region (Love et al. 2002). Information on habitat requirements for most rockfishes is limited despite years of research, and even less is known about bocaccio in Puget Sound (Palsson et al. 2009; Drake et al. 2010). In general, most adult rockfish are associated with high relief, rocky habitats, which are limited in Hood Canal, while larval and juvenile stages of some rockfishes utilize open water and nearshore habitats as they grow. Reviews of rockfish habitat utilization in Puget Sound indicate that nearshore vegetated habitats are particularly important for some species and serve as nursery areas for juveniles (Palsson et al. 2009; Bargmann et al. 2010).

Palsson et al. (2009) indicate that in Puget Sound waters recruitment habitats may include nearshore vegetated habitats, or deep-water habitats consisting of soft and low relief rocky substrates. Much of the information presented below on bocaccio life history and habitat use is derived from other areas where bocaccio occur. Palsson et al. (2009) provides the most comprehensive review of Puget Sound rockfish species distributions and the relative number of occurrences. This review relied heavily on Miller and Borton (1980) data, but also included the review of historical literature, fish collections, unpublished log records, and other sources. Palsson et al. (2009) noted bocaccio were only recorded 110 times in their review of historical studies, with most records associated with sport catches from the 1970s in Tacoma Narrows and Appletree Cove (near Kingston). Only two records occurred for Hood Canal, both in the 1960s.

1.2.1.3. OCCURRENCE

Currently both sport and commercial fishing for rockfish in Hood Canal is prohibited, and no recent scientific surveys of these waters have occurred that document the recent prevalence of bocaccio in these waters. Although there have been no confirmed observations of bocaccio in Puget Sound for approximately 7 years (74 FR 18516), Drake et al. (2010) concluded that it is likely that bocaccio occur in low abundances. As a result, bocaccio have the potential to be affected by the proposed projects and are, therefore, included in the analysis.

1.2.2. Canary Rockfish

1.2.2.1. STATUS

Puget Sound canary rockfish were federally listed as threatened under the ESA in 2010 (75 FR 22276). Critical habitat for yelloweye rockfish, canary rockfish, and bocaccio of the Puget Sound Georgia Basin was designated in November 2014 (79 FR 68042). WDFW's April 2010 *Puget Sound Rockfish Conservation Plan* would be applicable to all rockfish in Puget Sound, including canary rockfish. The same stressors contributing to the decline of bocaccio affect canary rockfish (74 FR 18516; Palsson et al. 2009; Drake et al. 2010).

1.2.2.2. LIFE HISTORY

Canary rockfish range from Punta Blanca, Baja California, to the Shelikof Strait of Alaska, and are abundant from British Columbia to central California. Canary rockfish were once considered fairly common in the greater Puget Sound area (Kincaid 1919; Holmberg et al. 1962), although

little is known about their habitat requirements in these waters (Palsson et al. 2009; Drake et al. 2010). Recent reviews of Puget Sound rockfish and their habitats (Palsson et al. 2009; Bargmann et al. 2010; Drake et al. 2010) discuss habitat use by listed rockfish in general terms with little or no distinction between the species. Therefore, as discussed above for bocaccio, adult canary rockfish are considered associated with high-relief, rocky habitats, and larval and juvenile stages likely utilize open water and nearshore habitats. Much of the information presented below on canary rockfish life history and habitat use is derived from research from other areas where canary rockfish are more abundant. After review of historical rockfish records in Puget Sound, Palsson et al. (2009) noted 114 records of canary rockfish prior to the mid-1970s, with most records attributed to sport catch from the 1960s to 1970s in Tacoma Narrows, Hood Canal, San Juan Islands, Bellingham, and Appletree Cove. Within Hood Canal, 14 records occurred: 1 in the 1930s and at least 13 in the 1960s (Miller and Borton 1980).

1.2.2.3. OCCURRENCE

As mentioned for bocaccio, there is a moratorium on both sport and commercial fishing for rockfish in Hood Canal. With the absence of associated catch records, and limited scientific surveys of these waters, the prevalence of rockfish in waters adjacent to NAVBASE Kitsap Bangor remains unknown. Drake et al. (2010) concluded that canary rockfish occur in low and decreasing abundances in Puget Sound. Therefore, canary rockfish have the potential to be affected by the proposed projects and are, therefore, included in the analysis.

1.2.3. Yelloweye Rockfish

1.2.3.1. STATUS

Puget Sound yelloweye rockfish were federally listed as threatened under the ESA in 2010 (75 FR 22276). Critical habitat for yelloweye rockfish, canary rockfish, and bocaccio of the Puget Sound Georgia Basin was designated in November 2014 (79 FR 68042). WDFW's April 2010 *Puget Sound Rockfish Conservation Plan* would be applicable for all rockfish in Puget Sound, including yelloweye rockfish. The same stressors contributing to the decline of bocaccio affect yelloweye rockfish (74 FR 18516; Palsson et al. 2009; Drake et al. 2010).

1.2.3.2. LIFE HISTORY

Yelloweye rockfish are found from Ensenada, Baja California, to the Aleutian Islands in Alaska. They are abundant from southeast Alaska to central California, but extremely rare in Puget Sound. Review of historical rockfish in Puget Sound by Palsson et al. (2009) noted 113 documented yelloweye rockfish records associated with sport catch. Of these records, 14 occurred in Hood Canal waters: 1 in the 1930s and 13 in the 1960s (Miller and Borton 1980). Kincaid (1919) reported yelloweye rockfish used to be relatively common in the deep waters of Puget Sound. Due to the moratorium on both sport and commercial fishing for rockfish in Hood Canal, the absence of associated recent catch records, and no recent scientific surveys of these waters, the prevalence of yelloweye rockfish in these waters remains unknown. As discussed above for canary rockfish, recent reviews of Puget Sound rockfish species and their habitats (Palsson et al. 2009; Bargmann et al. 2010; Drake et al. 2010) suggest little distinction between these rockfish species in terms of habitat use in Puget Sound. Therefore, as discussed above for bocaccio, adult yelloweye rockfish are considered associated with deeper, high-relief, rocky habitats, and larval and juvenile stages may utilize open water and nearshore habitats.

1.2.3.3. OCCURRENCE

As mentioned for bocaccio, there is a moratorium on both sport and commercial fishing for rockfish in Hood Canal. With the absence of associated catch records, and limited scientific surveys of these waters, the prevalence of rockfish in waters adjacent to NAVBASE Kitsap Bangor remains unknown. Drake et al. (2010) concluded that yelloweye rockfish occur in low and decreasing abundances in Puget Sound. Therefore, yelloweye rockfish have the potential to be affected by the proposed projects and are, therefore, included in the analysis.

1.3. NON-ESA-LISTED SALMONIDS

1.3.1. Chum Salmon (Fall-run and Hatchery Fish)

1.3.1.1. LIFE HISTORY

The general life history of fall-run chum salmon is similar to that of summer-run fish. The greatest difference is that fall-run adults spawn a few months later than summer-run adults. Adult fall- and late-fall-run stocks of Hood Canal chum salmon return to their natal streams to spawn between November and January. Consequently, fall-run juvenile salmon out-migrate a little later than do summer-run juvenile salmon. The release of hatchery chum salmon is dependent on hatchery management practices. In general, hatchery releases are timed to occur after summer-run juveniles have past their peak out-migration to minimize competition for limited food resources, such as benthic amphipods. Since fall-run and hatchery origin chum are indistinguishable from the ESA-listed summer-run chum, without genetic analysis, their occurrence is presented in this section at a species level rather than as a seasonally distinguished ESU or run. Similar to pink salmon, the small size of the juvenile chum salmon upon arrival to the marine environment in spring limits their out-migration distribution to the intertidal and shallow subtidal environment for both refuge and available food sources.

1.3.1.2. OCCURRENCE

From the 1970s to mid-2000s, recently hatched out-migrating juvenile chum salmon have been captured along the Bangor shoreline from January through June (Schreiner et al. 1977; Salo et al. 1980; Bax 1983; SAIC 2006; Bhuthimethee et al. 2009), with peak catches from 2006 to 2008 occurring from March to April (SAIC 2006; Bhuthimethee et al. 2009). Relatively small numbers of chum were captured in May and June of 2006, and no chum were captured from July through September, suggesting that the out-migration was completed by July (SAIC 2006).

Chum salmon was documented as the most abundant salmonid along the Bangor shoreline during the 2005 to 2008 surveys, accounting for approximately 94.7 percent of the salmonid catch (Figure B-1) (SAIC 2006; Bhuthimethee et al. 2009). Chum salmon are also the most abundant hatchery fish reared in Hood Canal (SAIC 2006; Bhuthimethee et al. 2009). As with pink salmon, chum salmon released from hatcheries are not marked (fin clipped). Thus, hatchery chum captured in Hood Canal surveys are indistinguishable in the field from naturally spawned chum (SAIC 2006; Bhuthimethee et al. 2009).

1.3.2. Coho Salmon

1.3.2.1. LIFE HISTORY

Like many other salmonids in Washington State, coho salmon (*Oncorhynchus kisutch*) occur as both hatchery-reared and naturally spawned fish. For coho populations in this region, returning adult coho salmon are generally 3-year-olds, and spend approximately 18 months in fresh water and 18 months in marine habitats (Sandercock 1991). Compared to Chinook salmon, coho tend to spawn in smaller streams of modest gradient (Quinn 2005). With some variability, coho salmon generally spawn on a 3-year cycle. Adult coho salmon migrate to their natal streams for spawning from mid-September to mid-November. Following a winter incubation period of 4 to 5 months, the free-swimming fry emerge from the gravel in the spring (Weitkamp et al. 1995). During spring of the second year, Hood Canal coho smolts migrate to sea. Due to the extended period of freshwater rearing time, juvenile coho are larger (2.8 to 3.5 inches [7.1 to 8.9 centimeters]) than some of the other co-occurring salmonids (e.g., chum and pink salmon at 1 to 1.6 inches [2.5 to 4.1 centimeters]) when they reach the waters of Hood Canal (SAIC 2006; Bhuthimethee et al. 2009). As a result, coho are not as dependent on shallow waters for foraging and protection from predators and currents, and occur further offshore from the Bangor shoreline than other salmonids. Maturing coho spend an average of 16 to 20 months rearing in the ocean, then return to fresh water to spawn as 3-year-old adults (Sandercock 1991). Recent tagging investigations have shown that juvenile coho distribution and movement patterns are not well known (Rohde 2013), but that they have extended intrabasin residence times and may utilize nearshore marine for extended rearing periods, not just migratory corridors.

1.3.2.2. OCCURRENCE

Coho salmon captured in beach seine surveys between 2005 and 2006 were the second most abundant salmonid occurring along the Bangor shoreline, accounting for approximately 3.1 percent of the salmonid catch (Figure B-1) (SAIC 2006). There is a run-timing overlap between hatchery and naturally spawning coho during out-migration (Bhuthimethee et al. 2009). In 2006, Hood Canal hatcheries released 1.6 million coho smolts from late April through early June (SAIC 2006). Although these hatchery fish were released at a time when naturally spawned coho also occur, approximately 82 percent of these released fish showed no external hatchery markings (data reviewed in SAIC 2006).

1.3.3. Pink Salmon

1.3.3.1. LIFE HISTORY

Pink salmon (*Oncorhynchus gorbuscha*) are the most abundant salmon along the coast of the northeast Pacific Ocean and are also the smallest at maturity (Bonar et al. 1989; Heard 1991; Quinn 2005). Pink salmon only live for 2 years, with very little variability. In general, large runs of adult pink salmon occur in the fall of odd years (with corresponding large juvenile out-migrations in spring of even years), with much smaller runs occurring in the fall of even years. Adult pink salmon migrate from the ocean to their natal streams from August to September, with spawning occurring in freshwater gravel beds from September through October (Heard 1991). Following their winter emergence from the gravel, 4 to 5 months after spawning, pink salmon fry begin their migration to the marine waters of Hood Canal. Due to their small size (approximately 1.0 to 1.5 inches [2.5 to 3.8 centimeters]) when reaching marine waters,

including the NAVBASE Kitsap Bangor region (SAIC 2006; Bhuthimethee et al. 2009), these juveniles out-migrate in the nearshore, seeking food and refuge from predators along the shallow intertidal and shallow subtidal shorelines.

1.3.3.2. OCCURRENCE

Pink salmon generally occur every other year (the majority out-migrate in even years), and were the third most abundant salmonid occurring along the Bangor shoreline in 2005 and 2006. This species accounted for approximately 1.6 percent of the total salmonid catch from 2005 to 2008 (Figure B-1) (SAIC 2006). Though none of the NAVBASE Kitsap Bangor streams support spawning populations of pink salmon, juveniles from southern Hood Canal stream systems migrate in a northerly direction and occur in the vicinity of the project sites.

The Hoodsport Hatchery in southern Hood Canal rears pink salmon for release every other year at the end of the naturally spawned out-migration, usually in April. Currently this hatchery does not mark (fin-clip) pink salmon released in Hood Canal. As a result, recent surveys (2005 through 2008) were not able to distinguish between naturally produced and hatchery-reared pink salmon to determine differences in abundance, occurrence, or run-timing by source (SAIC 2006; Bhuthimethee et al. 2009). Newly emerged pink salmon have been captured along the Bangor shoreline as early as January and as late as June, with a peak occurrence in March to April (Schreiner et al. 1977; Salo et al. 1980; SAIC 2006; Bhuthimethee et al. 2009).

1.3.4. Cutthroat Trout

1.3.4.1. LIFE HISTORY

Spawning for cutthroat trout takes place in freshwater streams. By 2 or 3 years of age, juvenile cutthroat begin to migrate to marine waters. Generally, this migration occurs from March to June, with a peak out-migration in mid-May (Johnson et al. 1999). Upon entering marine waters, juvenile cutthroat form small schools and migrate along the nearshore waters. Some of these fish reside in Puget Sound whereas others enter coastal waters. Upon reaching maturity, cutthroat trout return to their natal streams for spawning, generally from July to December (Johnson et al. 1999). The spawned-out adults return to marine waters in late March or early April (Pacific States Marine Fisheries Commission 1996).

1.3.4.2. OCCURRENCE

Cutthroat trout are considered uncommon along the Bangor shoreline (Schreiner et al. 1977; Bax et al. 1978, 1980; Salo et al. 1980; SAIC 2006), representing less than 1 percent of the salmonids caught in beach seine studies conducted from 2005 to 2008 (Figure B-1) (SAIC 2006; Bhuthimethee et al. 2009). Both juvenile and adult cutthroat trout have been captured along the Bangor shoreline throughout the year, but peak abundance was in May and June from 2005 to 2008 (SAIC 2006; Bhuthimethee et al. 2009). At the Bangor waterfront, adult cutthroat were captured more frequently near the southern periphery and along the northern portion of the waterfront, away from the project sites. This may be the result of adult cutthroat attraction to the fresh water exiting Cattail Lake and Devil's Hole.

1.3.5. Sockeye Salmon

No documented runs of sockeye salmon occur within any of the tributaries of Hood Canal, with the nearest stock to Hood Canal occurring in Lake Washington (WDFW 2002). Other nearby populations of these fish include the Baker Lake and Lake Washington sockeye populations. Although a lone 12-inch sockeye was captured along the Bangor waterfront in March of 2006 (SAIC 2006), this fish was likely a stray individual sockeye stock from either Lake Washington, Fraser River, or British Columbia (Ruggerone 2006, personal communication). No other sockeye salmon have been captured conducted in the 1970s or 2000s along the Bangor shoreline (Schreiner et al. 1977; Bax et al. 1978, 1980; Salo et al. 1980; SAIC 2006, Bhuthimethee et al. 2009). Due to the primary absence of this species from the region of the projects, sockeye salmon are not discussed further in this document.

1.4. FORAGE FISH

Nearshore habitat requirements for forage fish are similar to those described in Section 2, below, for salmonids with respect to water and sediment quality, physical and biological habitat use, and underwater noise. One notable difference is that forage fish species use some areas of Puget Sound shorelines for spawning habitat, whereas salmonids use freshwater systems for spawning. Suitable spawning habitat for forage fish is species specific, and is discussed below for each species.

1.4.1. Pacific Herring

1.4.1.1. LIFE HISTORY

Pacific herring (*Clupea pallasii*) are relatively small (9-inch [22.9 centimeter]) schooling fish distributed along the Pacific coast from Baja California, Mexico, to the Bering Sea and northeast to the Beaufort Sea, Alaska. Adult herring feed primarily on planktonic crustaceans, and juveniles prefer a diet of crab and shrimp larvae. Herring are an important food resource for other species in Puget Sound waters. Puget Sound stocks of young herring spend at least their first year in Puget Sound, with some stocks displaying resident behavior, and others migrating in summer months to coastal areas of Washington and southern British Columbia (Bargmann 1998). The majority of herring spawning in Washington State waters occurs annually from late January through early April (Bargmann 1998). Herring deposit their eggs on intertidal and shallow subtidal eelgrass and marine algae. Large spawning areas are found with patchy distribution in northern Hood Canal (Stick and Lindquist 2009). However, the only documented herring spawning grounds potentially affected by the projects occur near Squamish Harbor (Figure 3.3–4).

1.4.1.2. OCCURRENCE

Pacific herring have been detected in small numbers during late winter months and large numbers in early summer months during recent surveys along the Bangor waterfront (SAIC 2006; Bhuthimethee et al. 2009). These very large (occasionally numbering in the thousands), but infrequent summer schools of herring can comprise the majority of all forage fish occurring along the Bangor shoreline, when these larger schools are present. As indication of school variability, in 2005 and 2008 Pacific herring represented less than 1 percent of the beach-seine captured forage fish at NAVBASE Kitsap Bangor, while in 2006 and 2007 they represented

73 percent and 84 percent, respectively, of all forage fish captured (SAIC 2006; Bhuthimethee et al. 2009), though these schools were captured in just a few sampling events.

OCCURRENCE AT LWI PROJECT SITES

In the 2005 to 2008 nearshore fish surveys, Pacific herring were captured at both LWI project sites (SAIC 2006; Bhuthimethee et al. 2009). The sampling effort was most comparable in effort and location in 2006, 2007, and 2008, due to a much lower 2005 sampling effort. Therefore, only the three comparable years are discussed below. A single sample location occurred in the immediate vicinity of the proposed north LWI project site. At the north LWI project site, less than one percent of all Pacific herring captured in 2008 occurred at the nearby sampling location (SAIC 2006; Bhuthimethee et al. 2009). In 2007, only 5 percent of all herring captured along the 15 waterfront sampling sites occurred at this location. However, in 2006, 49 percent of the Pacific herring catch occurred at this location. At the south LWI project site, two sampling locations occurred, immediately north and south of the proposed south LWI project site. At these sampling sites, only one Pacific herring was captured in 2006 and 2008 (SAIC 2006; Bhuthimethee et al. 2009). In 2007, however, of the 15 stations sampled along the waterfront, 10 percent of all herring captured occurred at these two stations (Bhuthimethee et al. 2009). In general, many more Pacific herring were captured at the one sampling location near the north LWI project site than the two sampling stations near the south LWI project site. However, these numbers largely reflect the capture of large schools of fish, and they likely do not indicate a difference in habitat quality or preference between the two locations. The study results indicate that Pacific herring collected along the NAVBASE Kitsap Bangor shoreline in late spring and summer can occur in distinct schools that are not large enough to extend across multiple sampling sites and they do not appear to be attracted to, reside for an extended period at, or show preference for a specific location.

OCCURRENCE AT THE SPE PROJECT SITE

The two fish survey sampling locations that occurred nearest to the SPE project site during the 2006, 2007, and 2008 sampling efforts occurred on either side of Carlson Spit, immediately south of the existing Service Pier structure (SAIC 2006; Bhuthimethee et al. 2009). The inconsistent capture of Pacific herring at this location was similar to that described for the two LWI project sites. Of the 12 stations sampled in 2006, the 2 located at Carlson Spit accounted for 24 percent of the Pacific herring captured. However, of the 15 stations sampled in 2007 and 2008, less than 1 percent of all Pacific herring captured occurred at these two sites. As discussed above, these numbers largely reflect the capture of large schools of fish on a few occasions, and likely do not indicate any preference of this location by Pacific herring.

1.4.2. Surf Smelt

1.4.2.1. LIFE HISTORY

Surf smelt (*Hypomesus pretiosus*) is a common and widespread nearshore forage fish throughout Washington marine waters (Penttila 2007). There is no evidence of widespread migrations to and from Puget Sound to the outer coast. Surf smelt in Puget Sound do not appear to form large schools in open water, instead occurring more exclusively in nearshore waters. This is supported by mid-water research trawl surveys with catches suggesting a distinct preference for more shallow, nearshore habitats and a tendency to remain close to the bottom at all times. In fact, as

indicated by Penttila (2007), young-of-the-year surf smelt are virtually ubiquitous along Puget Sound shorelines. Surf smelt are schooling plankton feeders, with an apparent preference for calanoid copepods, along with other small, epibenthic crustaceans and tunicates (Simenstad et al. 1988; Penttila 2007).

These small (9-inch [22.9 centimeters]) schooling fish are distributed along the Pacific coast from Long Beach, California, to Chignik Lagoon, Alaska. During 2005–2006 beach seine surveys, surf smelt were the second most abundant forage fish captured, representing 20 percent of the total forage fish catch (SAIC 2006). As with other forage fish species, surf smelt are an important component in Puget Sound, both as a food resource in the marine food web and as part of the commercial fishing industry.

In southern Hood Canal surf smelt spawn most frequently in the fall and winter. However, in many other regions of Puget Sound, including northern Hood Canal, spawning can occur year round. Potential surf smelt spawning habitat includes beaches composed of mixed sand and gravel in the uppermost one-third of the tidal range, from approximately +7 feet up to extreme high water (Penttila 2007). Although Penttila (1997) found no surf smelt spawning grounds along the Bangor waterfront during surveys conducted from May 1996 through June 1997, they may utilize the northern portion of Squamish Harbor (at the northern boundary of the area affected by the projects) for spawning.

1.4.2.2. OCCURRENCE

In nearshore beach seine surveys conducted from 2005 to 2008, surf smelt were most abundant along the Bangor waterfront in late spring through summer (SAIC 2006; Bhuthimethee et al. 2009).

OCCURRENCE AT LWI PROJECT SITES

Juvenile surf smelt have been found to rear in nearshore waters (Bargmann 1998) and were captured along the shoreline near both LWI project sites from January through the mid-summer months (SAIC 2006; Bhuthimethee et al. 2009). In 2006, of the 12 locations sampled, less than 1 percent of all surf smelt were captured at the one sampling location in the vicinity of the north LWI project site. However, in 2007 and 2008 when 15 locations were sampled, 5 percent and 34 percent, respectively, of the surf smelt captured occurred at the north LWI project site. The survey findings were similar for the south LWI project site. At this site, two sampling locations occurred, immediately north and south of the proposed site. In 2006, of the 12 locations sampled, less than 2 percent of all surf smelt were captured at the two sampling locations in the vicinity of the south LWI project site. However, in 2007 and 2008, when 15 locations were sampled, 10 percent and 34 percent, respectively, of the surf smelt captured occurred at the two sampling locations that occur in the vicinity of the site. Although occurring somewhat more broadly among sampling locations than herring, surf smelt also occur in distinct schools, and do not appear to be attracted to, reside for any extended period at, or show preference toward any specific location along the waterfront. Instead, when these schools occur they appear to be using the nearshore environment as a migratory pathway, similar to salmonids.

OCCURRENCE AT SPE PROJECT SITES

The two fish survey sampling locations that occurred nearest to the SPE project site during the 2006, 2007, and 2008 sampling efforts occurred on either side of Carlson Spit, immediately

south of the existing Service Pier structure (SAIC 2006; Bhuthimethee et al. 2009). Juvenile and adult surf smelt were captured in very low abundances along the shoreline near the SPE project site (SAIC 2006; Bhuthimethee et al. 2009). In 2006, of the 12 stations sampled, less than 1 percent of all surf smelt captured occurred at the 2 sampling locations. In 2007 and 2008, 15 stations were sampled, with less than 1 percent and less than 5 percent, respectively, of all surf smelt occurring at these 2 sampling locations.

1.4.3. Pacific Sand Lance

1.4.3.1. LIFE HISTORY

The Pacific sand lance (*Ammodytes hexapterus*), another relatively small (8-inch) schooling fish, occurs throughout the coastal northern Pacific Ocean between the Sea of Japan and southern California, across Arctic Canada, and throughout the Puget Sound region. All life stages of sand lance feed on planktonic organisms, primarily crustaceans, with juveniles showing a preference for calanoid copepods (Penttila 2007). As with other forage fish, the Pacific sand lance is an important part of the trophic link between zooplankton and larger predators in local marine food webs. Bargmann (1998) indicated that 35 percent of all juvenile salmon diets and 60 percent of the juvenile Chinook diet comprised sand lance. Other regionally important species (such as Pacific cod, Pacific hake, and dogfish) feed heavily on juvenile and adult sand lance.

Pacific sand lance are the only forage fish species with spawning habitat documented along the Bangor shoreline. Sand lance deposit eggs on a range of nearshore substrates, from soft, pure, fine sand beaches to beaches armored with gravel up to 1.2 inches (3 centimeters) in diameter; however, most spawning appears to occur on the fine-grained substrates (Bargmann 1998). Spawning occurs at tidal elevations ranging from 5 feet (1.5 meters) above to about the mean higher high water (MHHW) line. Sand lance spawning activity occurs annually from early November through mid-February. Because the sand lance spawns on sand gravel beaches in the upper intertidal zone throughout the increasingly populated Puget Sound basin, it is particularly vulnerable to the cumulative impacts from various types of shoreline development.

Although this species is common and widespread in Puget Sound, very little is known about the life history or biology of sand lance populations in Washington State. Pacific sand lance are highly unusual among local forage fish species in their habit of actively burrowing into nearshore sand-gravel bottom sediments during parts of their diurnal and seasonal cycles of activity (Quinn 1999). Pacific sand lance are known to burrow in soft sediments in intertidal and subtidal areas to escape predation and conserve energy, because they lack a swim bladder to aid in swimming. While slightly older Pacific sand lance have been shown to occupy or be associated with intertidal eelgrass habitats, young-of-the-year sand lance are negatively correlated with these same habitats (Haynes et al. 2008). In addition to age-related habitat preferences, Haynes et al. (2008) postulated that there may be different sediment preferences of sand lance depending on whether the habitat occurs in intertidal or subtidal regions. Although Pacific sand lance are largely associated with these nearshore spawning habitats, an investigation of deeper water sand waves and benthic sediments within the San Juan Islands detected habitat use and occurrence of eggs and non-larval ages of sand lance (Greene et al. 2011).

1.4.3.2. OCCURRENCE

OCCURRENCE AT LWI PROJECT SITES

Pacific sand lance were the third most abundant forage fish collected along the Bangor waterfront during recent surveys and comprised 7 percent of the total forage fish catch (SAIC 2006). At the north LWI project site, Pacific sand lance spawning habitat has been documented along an estimated 1,000-foot (305-meter) length of the shoreline extending from the proposed abutment location southward (Figure 3.3–4) (WDFW 2013). At this location, in 2006 and 2007 less than 1 percent of all sand lance captured along the waterfront occurred in the vicinity of the north LWI project site (SAIC 2006; Bhuthimethee et al. 2009). However, in 2008, 57 percent of all sand lance captured along the NAVBASE Kitsap Bangor shoreline, occurred at this location. At the south LWI project site, spawning habitat has been documented along the shoreline approximately 500 feet (150 meters) north of the proposed abutment location, extending approximately 1,600 feet (488-meters) north (Figure 3.3–4) (WDFW 2013). In 2006 and 2007 at the two sampling locations in the vicinity of the south LWI project site, less than 1 percent of all sand lance captured along the waterfront occurred in this area. However, in 2008, 16 percent of all sand lance captured along the NAVBASE Kitsap Bangor shoreline occurred at the two sampling locations in the vicinity of the south LWI project site.

OCCURRENCE AT SPE PROJECT SITES

The Pacific sand lance spawning habitat that occurs on both sides of Carlson Spit extends northward to include intertidal habitats under the Service Pier causeway (Figure 3.3–4) (WDFW 2013). The two nearest fish survey locations occurred on either side of Carlson Spit (SAIC 2006; Bhuthimethee et al. 2009). In 2006 Pacific sand lance captured at these 2 locations accounted for 22 percent of all Pacific sand lance captured from the 12 NAVBASE Kitsap Bangor shoreline locations sampled that year. In 2007 and 2008, when 15 locations were sampled, the Pacific sand lance captured in the vicinity of the SPE site represented 7 percent and 6 percent, respectively, of all Pacific sand lance captured along the NAVBASE Kitsap Bangor shoreline.

2.0 HABITAT CONDITIONS

Salmonids are most abundant in Hood Canal during the spring juvenile salmonid out-migration (Schreiner et al. 1977; Prinslow et al. 1980; Bax 1983; Salo 1991; SAIC 2006; Bhuthimethee et al. 2009), when these fish are dependent on nearshore habitats for foraging and refuge. NMFS, USFWS, and the Pacific Fisheries Management Council (PFMC) have prepared guidance on the evaluation of properly functioning conditions (PFCs) for salmonids in freshwater systems. Although this Matrix of Pathways Indicators has only been constructed for freshwater and not for marine systems, marine and estuarine habitat requirements for juvenile and adult salmonids have been described by many authors (Fresh et al. 1981; Shepard 1981; Healey 1982; Levy and Northcote 1982; Weitkamp et al. 2000).

Ideally, reliable stock-specific habitat requirements would exist for all populations of listed species that would allow the impacts of an action to be quantified in terms of population impacts (NMFS 1999). However, as stated in the Habitat Approach, an August 1999 supplement to the National Oceanic and Atmospheric Administration (NOAA) Fisheries guidance document *Making Endangered Species Act Determinations of Effects for Individual or Grouped Action at*

the Watershed Scale (NMFS 1996), in the absence of population-specific information, an assessment must define the biological requirements of a listed fish species. These requirements are defined in terms of PFCs, which are described as the sustained presence of natural habitat-forming processes necessary for the long-term survival of the species through the full range of environmental variation (NMFS 1999). Indicators of PFCs vary in different landscapes based on unique physiological and geologic features (NMFS 1999). Since aquatic habitats are inherently dynamic, PFCs are defined by the persistence of natural processes that maintain habitat productivity at a level sufficient to ensure long-term survival, and are not necessarily defined by absolute thresholds and parameters (NMFS 1999). A more detailed description of the potential impacts of the proposed projects on ESA-listed marine fish using the PFC analysis approach is provided in the Biological Assessment.

2.1. WATER AND SEDIMENT QUALITY

As described in greater detail in Section 3.1.1.1.1, turbidity along the Bangor waterfront meets water quality standards and is considered properly functioning. DO levels meet the extraordinary standard for surface waters (3 to 20 feet [1 to 6 meters] in depth) year round and for deep water (66 to 197 feet [20 to 60 meters] in depth) most of the year, although deeper waters can drop to a fair standard in late summer (Hafner and Dolan 2009; Phillips et al. 2009; Hood Canal Dissolved Oxygen Program 2009).

2.1.1. Water and Sediment Quality at the LWI Project Sites

Existing nearshore current patterns along the shoreline at both LWI project sites, primarily driven by tidal exchange, are described in greater detail in Section 3.1.1.1.1. The nearest freshwater source to the north LWI project site is the Hunter's Marsh system, located immediately behind the Explosives Handling Wharf (EHW)-1 structure, south of the north LWI project site. The strong tides and currents, combined with a small outflow from the marsh, result in well-mixed waters at the north LWI project site with no habitat that acts as an estuary. The south LWI project site occurs near the Devil's Hole outlet. The freshwater exiting the lake has contributed to higher temperatures and lower salinities in the nearshore waters at this location (Phillips et al. 2009). Temperature, pH, and other water quality parameters meet water quality standards, and there is no known water contamination within the general LWI project areas (Section 3.1.1.1.2).

Sediment investigation studies have shown that marine sediments in the vicinity of the LWI project sites are composed of gravelly sands with some cobbles in the intertidal zone, transitioning to silty sands in the subtidal zone (Hammermeister and Hafner 2009). In general, sediment characterization studies along the waterfront demonstrated that organic contaminants, metals, polycyclic aromatic hydrocarbons (PAHs), phthalates, phenols, and some chlorinated pesticides occur at concentrations below the sediment quality standards (SQS) (Section 3.1.1.1.3).

2.1.2. Water and Sediment Quality at the SPE Project Site

Temperature, pH, and other water quality parameters near the SPE project site meet water quality standards, and there is no known water contamination within the general SPE project area (Section 3.1.1.1.2).

As discussed above for the LWI project sites, sediment characterization studies along the waterfront, including the SPE project site, demonstrated that organic contaminants, metals, PAHs, phthalates, phenols, and some chlorinated pesticides occur at concentrations below the cleanup thresholds (see Section 3.1.1.1.3). Additionally, results from the SAIC 2007 sediment survey at Bangor (Hammermeister and Hafner 2008) indicate that surficial sediments near Service Pier consist of 73 to 93 percent sand and gravel, with total organic carbon levels ranging from 0.4 to 2 percent (Section 3.1.1.1.3). There was no evidence of elevated metals, PAHs, pesticides, polychlorinated biphenyls, and all sediment contaminant concentrations were below the corresponding SQS guidelines.

2.2. PHYSICAL HABITAT AND BARRIERS

The eight in-water structures along the waterfront (Carderock Pier, Service Pier, Keyport/Bangor Dock (KB Dock), Delta Pier, Marginal Wharf, EHW-1, EHW-2 [under construction] and the Magnetic Silencing Facility [MSF]) likely act as migrational barriers to shoreline migrating juvenile salmon. Although there are many nearshore structures in the southern portion of Hood Canal, primarily smaller docks, NAVBASE Kitsap Bangor represents the only industrial waterfront within the Hood Canal area of Puget Sound. Within northern Hood Canal, nearshore development is limited. A few docks and a small pier occur at Seabeck, more than 8 miles (13 kilometers) to the south, and the Hood Canal Bridge, approximately 7 miles (11 kilometers) north of the MSF. The remainder of the northern Hood Canal shoreline is generally undeveloped. For the Marginal Wharf, the large number of piles, their close spacing, the low height-over-water design, and the nearshore location of the wharf likely make this the greatest barrier to migrating juvenile salmon. Most of the other structures have been designed to have the majority of their overwater structures farther offshore, have a greater height-over-water, and an increased separation between piles. Recent fish surveys have captured large numbers of salmonids behind and along the shoreline immediate to the north of each structure, including Marginal Wharf (SAIC 2006; Bhuthimethee et al. 2009), suggesting juvenile salmonids are able to migrate around, or through, these structures. Although statistical analyses of those surveys did not indicate a significant barrier effect of these nearshore structures (Bhuthimethee et al. 2009), they were designed to detect the occurrence, distribution, and habitat use of nearshore fish species, and did not include a study design specific for detecting the potential barrier effects of nearshore NAVBASE Kitsap Bangor structures.

2.2.1. Physical Habitat and Barriers at the LWI Project Sites

Structures along the entire waterfront and in the immediate vicinity of the north and south LWI project sites include in-water physical structures, overwater shading and overwater lighting, considered as potential barriers to juvenile salmonid migration in Puget Sound (Simenstad et al. 1999; Nightingale and Simenstad 2001a).

Existing physical barriers at the north LWI project site includes the piles supporting the EHW-1 causeways, less than 1,000 feet (305 meters) south of the north LWI footprint. Although some delay or slight alteration in migratory behavior of nearshore migrating fish may occur due to the presence of the causeways, the large height over water reduces the potential shading effect, and the larger separation between piles, relative to Marginal Wharf, reduces this effect.

Existing physical barriers at the south LWI project site includes the piles supporting Delta Pier, less than 1,000 feet (305 meters) north of the south LWI footprint. As with the north LWI project site, structural designs of these causeways reduce the potential shading effect and

minimize the barrier effect of in-water piles; however, some delay or slight alteration in migratory behavior of nearshore migrating fish may occur due to the presence of in-water structures supporting Delta Pier.

2.2.2. Physical Habitat and Barriers at the SPE Project Site

In addition to the Service Pier itself, in-water structures in the vicinity of the SPE project site include KB Dock, approximately 500 feet (152 meters) to the north, and Carderock Pier approximately 500 feet to the south. The existing structures along the entire waterfront, and in the immediate vicinity of the SPE project site, may delay or slightly alter the existing migratory behavior of nearshore migrating fish due to factors such as in-water physical structures, overwater shading, and overwater lighting.

2.3. BIOLOGICAL HABITAT

2.3.1. Prey Availability

The large majority of salmonids that occur along the Bangor waterfront are juveniles, recently emerged from their natal streams, migrating toward the Pacific Ocean (Schreiner et al. 1977; Salo et al. 1980; Bax 1983; SAIC 2006; Bhuthimethee et al. 2009). At these smaller sizes, juvenile salmonids prefer small benthic invertebrate prey, although larger age-0 fish will prey on smaller fish. Other species, notably coho salmon, can occur as larger age-1 fish during their out-migration, and use larval and juvenile forage fish as a food resource during their migration. Subadult and adult salmonids use juvenile and adult forage fish, among other species, as a food resource (Healey 1991; Salo 1991; Sandercock 1991). A detailed description of forage fish life history and occurrence, including prey resources such as benthic invertebrates used extensively by the younger, more abundant, juvenile salmonids, is provided in Section 1.4 in this appendix.

The presence of small invertebrate prey resources such as harpacticoid copepods, gammarid and corophoid amphipods, which are preferred juvenile salmon prey sources (Healey 1991; Salo 1991; Webb 1991a,b; Fujiwara and Highsmith 1997; HCCC 2005), indicate an epibenthic community capable of providing suitable food resources during the juvenile salmon out-migration along the Bangor shoreline.

2.3.1.1. PREY AVAILABILITY AT THE LWI PROJECT SITES

As described in Section 3.2.1.1.3, benthic organisms, including a number of preferred amphipod species, are abundant and diverse at both LWI project sites. Larger eelgrass beds along the Bangor shoreline, such as the one at the south LWI project site (SAIC 2009), were identified by Salo et al. (1980) as superior foraging habitats for juvenile salmonids due to high standing stocks of their preferred prey. However, the eight nearshore docks, piers, or wharves that occur along the Bangor waterfront include piles and overhead shading of benthic habitat reduce productivity of benthic habitat in the immediate vicinity of these structures.

2.3.1.2. PREY AVAILABILITY AT THE SPE PROJECT SITE

As described in Section 3.2.1.1.3, benthic organisms that occur at the SPE project site are expected to be less abundant than occur in dense eelgrass beds, elsewhere along the shoreline. The SPE project site is located in waters deeper than 30 feet (9 meters) below mean lower low water (MLLW), generally the depth at which eelgrass becomes light limited. An adjacent

eelgrass bed likely supports an invertebrate community providing foraging opportunities for juvenile salmonids. However, the existing overwater trestles and decking result in direct shading and reduced productivity of benthic habitat in the immediate vicinity of these structures.

2.3.2. Aquatic Vegetation

Juvenile salmonids use nearshore marine aquatic vegetation, notably eelgrass, as forage and refuge habitat during their migration from natal streams (Simenstad and Cordell 2000; Nightingale and Simenstad 2001a,b; Shafer 2002). Marine vegetation communities, including eelgrass beds, in Puget Sound provide a unique habitat, supporting a variety of invertebrates, such as copepods, amphipods, and snails, which might otherwise not be found on soft sediments (Mumford 2007). As indicated by Salo et al. (1980), the copepods and other zooplankton found in these habitats represent the major food base for the food chain in Puget Sound, specifically for small and juvenile fish including forage fish and salmonids.

2.3.2.1. AQUATIC VEGETATION AT THE LWI PROJECT SITES

The existing marine vegetation community is considered to be healthy and diverse at both LWI project sites, as described in Section 3.2.1.1.2. However, the EHW-1 structure occurs immediately to the south of the north LWI project site, shading the marine vegetation community in its footprint. The presence of this structure likely limits the southern extent of the eelgrass bed at the north LWI project site. The south LWI project site, includes an extensive eelgrass bed fed by the freshwater outflow of Devil's Hole on a small intertidal delta. The combination of shallow waters with plentiful nutrients and no shade likely contributes to the health of the marine vegetation community at this site. Similar to benthic and forage fish spawning habitat, more aquatic vegetation habitat likely would have been present prior to the nearshore construction of the existing piers or wharves. Therefore, it can be assumed that, at a minimum, the reduction in light attenuation due to the presence of these overwater structures limits the suitability of benthic habitats in their immediate vicinity to support healthy aquatic vegetation.

2.3.2.2. AQUATIC VEGETATION AT THE SPE PROJECT SITE

Although the SPE project site occurs in deeper waters, where marine vegetated communities become light limited (generally at depths greater than 30 feet [9 meters] MLLW), a narrow band of eelgrass occurs in the intertidal habitat long the shoreline (Section 3.2.1.1.2). In addition to the light limitation of deeper water, as with other habitats located near overwater structures, at a minimum, the reduction in light attenuation due to the presence of the existing Service Pier, and its causeway, likely contributes to reduced benthic habitat productivity, including healthy aquatic vegetation, in the immediate project vicinity.

2.4. UNDERWATER NOISE

Elevated underwater noise from anthropogenic sources has been found to alter the distribution, behavior, and health of fish that are present during these conditions (Hastings 2002; Hastings and Popper 2005; Popper et al. 2006). The existing underwater noise along the Bangor waterfront is attributed to a variety of both natural and human-related sources. Average underwater noise levels measured along the Bangor waterfront are elevated over ambient conditions due to waterfront operations, but are within the minimum and maximum range of measurements taken at similar environments within Puget Sound.

With respect to underwater noise impacts on fish, the presence of an internal air (swim) bladder to maintain buoyancy likely makes these species more susceptible to injury from underwater noise. This bladder is susceptible to expansion/decompression when a pressure wave from underwater noise is encountered. When the pressure is applied rapidly and at a sufficient level, rapid expansion/decompression is fatal for fish. However, underwater noise threshold criteria, established by a multi-agency working group, currently do not differentiate between species with air bladders and those without them (Fisheries Hydroacoustic Working Group 2008). Additional details regarding fish hearing capabilities is provided in Section 3.0, below.

3.0 FISH HEARING AND RESPONSE TO UNDERWATER SOUND

The degree to which an individual fish would be affected by underwater sound depends on a number of variables, including (1) species of fish, (2) fish size, (3) presence of a swim bladder, (4) physical condition of the fish, (5) maximum sustained sound pressure and frequency, (6) shape of the sound wave (rise time), (7) depth of the water, (8) depth of the fish in the water column, (9) amount of air in the water, (10) size and number of waves on the water surface, (11) bottom substrate composition and texture, (12) effectiveness of bubble curtain sound/pressure attenuation technology (if used for mitigation), (13) tidal currents, and (14) presence of predators (NMFS 2005b). Depending on these factors, effects on fish from underwater sound can range from changes in behavior to immediate mortality. There has been no documented injury or mortality resulting from the use of vibratory hammers; however, fish injury has been documented during installation of steel piles.

3.1. PHYSIOLOGICAL RESPONSES

As with underwater noise impacts on behavior, injury threshold levels and corresponding effects on fish at different intensities of underwater sound are unclear (Hastings and Popper 2005). Many of the previous studies cited for the physical effects, including injury and mortality, of underwater sound on fish were based on seismic air gun and underwater explosives studies (Hastings and Popper 2005). Physical effects from these types of impulsive sounds can include swim bladder, otolith, and other organ damage; hearing loss; and mortality (Hastings and Popper 2005).

Fish with swim bladders, including salmonids and larval rockfish, are more susceptible to barotrauma from impulsive sounds (sounds of very short duration with a rapid rise in pressure) because of swim bladder resonance (vibration at a frequency determined by the physical parameters of the vibrating object). A sound pressure wave can be generated from an impulsive sound source, such as an impact hammer striking a steel pile. When this wave strikes a gas-filled space, such as a swim bladder, it causes that space to vibrate (expand and contract) at its resonant frequency. When the amplitude of this vibration is sufficiently high, the pulsing swim bladder can press against and strain adjacent organs, such as the liver and kidney. This pneumatic compression can cause injury in the form of ruptured capillaries, internal bleeding, and maceration of highly vascular organs (CALTRANS 2002). Larval rockfish generally develop a swim bladder from two to three weeks after their birth (Tagal et al. 2002), but may be vulnerable to harm from noise before the bladder develops. However, not all pile driving is the same with respect to generating a sound pressure wave. In general, larger steel piles being driven by an impact hammer generate more biologically harmful pressure waves than smaller steel piles, similar-sized steel piles generate more harmful pressure waves than concrete piles when being

driven by an impact hammer, and piles driven using a vibratory hammer generally do not produce a pressure wave sufficient to cause barotrauma effects on fish that can result from impact hammers. More detailed information on underwater sound produced from pile driving is provided in Appendix D.

Hastings and Popper (2005) also noted that sound waves can cause different types of tissue to vibrate at different frequencies, and that this differential vibration can cause tearing of mesenteries and other sensitive connective tissues. Exposure to high noise levels can also lead to injury through “rectified diffusion,” the formation and growth of bubbles in tissues. These bubbles can cause inflammation; cellular damage; and blockage or rupture of capillaries, arteries, and veins (Crum and Mao 1996; Vlahakis and Hubmayr 2000; Stroetz et al. 2001). These effects can lead to overt injury or mortality. Death from barotrauma and rectified diffusion injuries can be instantaneous or delayed for minutes, hours, or even days after exposure.

Even in the absence of mortality, elevated noise levels can cause sublethal injuries affecting survival and fitness. Similarly, if injury does not occur, noise may modify fish behavior that may make them more susceptible to predation. Fish suffering damage to hearing organs may suffer equilibrium problems and have a reduced ability to detect predators and prey (Turnpenny et al. 1994; Hastings et al. 1996). Other types of sublethal injuries can place the fish at increased risk of predation and disease. Adverse effects on survival and fitness can occur even in the absence of overt injury. Exposure to elevated noise levels can cause a temporary shift in hearing sensitivity (referred to as a temporary threshold shift, or TTS), decreasing sensory capability for periods lasting from hours to days (Turnpenny et al. 1994; Hastings et al. 1996).

The severity of effects from high noise levels produced by impact-driving of steel piles depends on several factors, including the size and species of fish exposed. Regardless of species, smaller fish appear to be far more sensitive to injury of non-auditory tissues (Yelverton et al. 1975). For example, NMFS biologists observed that approximately 100 surf perch from three different species (*Cymatogaster aggregata*, *Brachystius frenatus*, and *Embiotoca lateralis*) were killed during impact pile driving of 36-inch (91-centimeter) diameter steel pilings at Bremerton, Washington (Stadler, NMFS, 2002, personal observation). Dissections revealed complete swim bladder destruction across all species in the smallest fish (7.6 centimeters fork length), while swim bladders in the largest fish (16.51 centimeters fork length) were nearly intact. However, swim bladder damage was typically more extensive in *C. aggregata* compared to *B. frenatus* of similar size. Because of their large size, adult salmon can tolerate higher noise levels and are generally less sensitive to injury of non-auditory tissues than juveniles (Hubbs and Rechnitzer 1952). However, no information is available to determine whether or not the risk of auditory tissue damage decreases with increasing size of the fish.

3.2. BEHAVIORAL RESPONSES

Data are limited for assessing the effects of anthropogenic-produced underwater sound on fish behavior (Hastings and Popper 2005; Popper and Hastings 2009). Of those studies investigating behavioral responses to underwater sound, not all collected the underwater sound data using a similar method, making comparisons between studies difficult (Hastings and Popper 2005). Part of the difficulty is that there are many different anthropogenic noise sources, with each source producing different types of underwater sound (e.g., impulsive vs. non-impulsive sound). Existing studies of fish behavioral response to underwater noise have investigated a variety of noise sources, including pile driving, seismic air gun, sonar, and vessel noise. Depending on the

noise source, the physical environment, and the fish species, behavioral responses can vary. A summary of studies that include an investigation of fish behavior reviewed for this EIS is provided below.

A number of studies have been conducted that indicate fish under natural settings display a behavioral or startle response to anthropogenic-produced underwater noise. Wardle et al. (2001) examined the behaviors of various fish species (e.g., gadoids, saithe, whiting, and small cod) on a reef in response to seismic air guns that were calibrated to have a peak level of 210 dB re 1 μPa at 16 meters from the source and 195 dB re 1 μPa at 109 meters from the source. Although they found that fish displayed a startle response, the noise did not chase the fish away and resulted in no permanent changes in the behavior of fish on the reef over the course of the study.

Slotte et al. (2004) utilized a vessel with two seismic sources, each of 20 air guns and 10 hydrophone streamers, and investigated the change in abundance of pelagic fish (including blue whiting and herring) relative to the seismic noise source. Regardless of species, Slotte et al. (2004) found that fish in the area of the air guns appeared to move to greater depths after ensonification compared to their vertical position prior to air gun usage. However, because the acoustic mapping prior to the shooting along some of the seismic transects gave no indications of short-term reactions, it was not evident whether a startle response occurred and the findings were inconclusive.

In a caged fish study, investigating the effects of a seismic air gun on five species of rockfish (*Sebastodes* spp.), Pearson et al. (1992) found that the general threshold for startle response occurred at 180 dB re 1 μPa . Behaviors varied between species, although fish generally formed tighter schools and remained somewhat motionless (Pearson et al. 1992). Skalski et al. (1992) found that, following the noise produced from a seismic air gun at the base of rockfish aggregations (186 dB peak re 1 μPa), the average rockfish catch for hook and line surveys decreased by 52 percent. Fathometer observations showed that the rockfish schools did not disperse but remained aggregated in schooling patterns similar to those prior to exposure to this noise. However, these aggregations elevated themselves in the water column, away from the underwater noise source.

Other studies have shown that some fish species may habituate to underwater noise (Feist 1991; Feist et al. 1992; Nedwell et al. 2006; Ruggerone et al. 2008) and would continue to occur within an area where underwater noise was well above background levels. Feist (1991) and Feist et al. (1992) investigated the effects of impact pile driving on the behavior of juvenile pink and chum salmon. Observers were placed at various locations and distances from the noise source. A hydrophone was placed at a specific distance from the noise source in an attempt to correlate fish behavior with levels of underwater sound. Feist et al. (1992) concluded that pile driving has an impact on the distributions and behavior of juvenile chum and pink salmon, although the findings suggest no change in overall fish abundance due to elevated underwater sound. Observations included startle responses and changes in general behavior and school size. However, pile driving did not appear to affect foraging of either species. Unfortunately, correlating behavioral effects of these salmonids relative to a specific underwater sound was not possible due in part to the study design where observers could not see fish in deeper environments, and due to methodological and logistics problems.

Ruggerone et al. (2008) investigated the behavioral response of juvenile coho salmon placed in cages at various distances from piles being driven with an impact hammer. Results indicated that coho salmon did not consistently exhibit a startle response during the first or subsequent hammer

strikes of each pile. A brief startle response was observed during 4 of 14 first-strikes (29 percent of piles), and during 1 of 14 second-strokes (7 percent). Gut content analysis indicated that both test and control fish readily consumed food. Similarly, based on an investigation of behavioral responses of brown trout (a surrogate for other salmonids), Nedwell et al. (2006) found that fish placed in cages at distances as close as 98 and 177 feet (30 and 54 meters) from a vibratory pile driver driving 36-inch and 20-inch (0.9-meter and 0.5-meter) piles showed very little to no behavioral response, including a startle response, to the underwater sound generated from the activity. However, the study acknowledged that brown trout lack the hearing sensitivity of other salmonids. Further, some acoustic experts have shown hesitancy to include fish behavioral findings from caged fish studies into the development of criteria.

In a critical review of studies investigating the effects of underwater sound on fish, Popper and Hastings (2009) concluded that “very little is known about effects of pile driving and other anthropogenic sounds on fishes, and that it is not yet possible to extrapolate from one experiment to other signal parameters of the same sound, to other types of sounds, to other effects, or to other species.” Since sufficient investigations with similar methodologies regarding the behavioral response of fish to anthropogenic noise sources are limited, threshold criteria for this effect have not been developed. As a result, the current approach for estimating the distances from an underwater noise source at which a fish will display a behavioral response are the guideline criteria of 150 dB RMS described by Hastings (2002).

4.0 LITERATURE CITED

- Bargmann, G. 1998. Forage Fish Management Plan. Washington State Department of Fish and Wildlife, Olympia, WA. <http://wdfw.wa.gov/publications/00195/wdfw00195.pdf>.
- Bargmann, G.G., W.A. Palsson, C. Burley, H. Cheng, D. Friedel, and T. Tsou. 2010. Revised Draft: Environmental impact statement for the Puget Sound Rockfish Conservation Plan (including preferred range of actions). Washington Department of Fish and Wildlife, Olympia, WA. April 6, 2010.
- Bax, N.J. 1983. The early marine migration of juvenile chum salmon (*Oncorhynchus keta*) through Hood Canal: Its variability and consequences. Ph.D. dissertation, University of Washington, Seattle, Seattle, WA.
- Bax, N.J., E.O. Salo, and B.P. Snyder. 1980. Salmonid outmigration studies in Hood Canal. Final report, Phase V, January to July 1979. Fisheries Research Institute, College of Fisheries, University of Washington. Seattle, WA. FRI-UW-8010.
- Bax, N.J., E.O. Salo, B.P. Snyder, C.A. Simenstad, and W.J. Kinney. 1978. Salmonid outmigration studies in Hood Canal. Final report, Phase III, January to July 1977. Fisheries Research Institute, College of Fisheries, University of Washington. Seattle, WA. FRI-UW-7819.
- Bhuthimethee, M., C. Hunt, G. Ruggerone, J. Nuwer, and W. Hafner. 2009. NAVBASE Kitsap Bangor fish presence and habitat use, Phase III field survey report, 2007–2008. Prepared by Science Applications International Corporation, Bothell, WA, and Natural Resources Consultants, Inc. (Ruggerone), Seattle, WA. Prepared for BAE Systems Applied Technologies, Inc., Rockville, MD.
- Bonar, S.A., G.B. Pauley, and G.L. Thomas. 1989. Species profiles: life histories and environmental requirements of coastal fishes and invertebrates (Pacific Northwest)—pink salmon. U.S. Fish Wildl. Serv. Biol. Rep. 82(11.88). U.S. Army Corps of Engineers, TR EL-82-4. 18 pp.
- Busby, P.J., T.C. Wainwright, G.J. Bryant, L.J. Lierheimer, R.S. Waples, F.W. Waknitz, and I.V. Lagomarsino. 1996. Status review of west coast steelhead from Washington, Oregon, and California. NOAA Technical Memo NMFS-NWFSC-27. U.S. Department of Commerce. 261 pp. <http://www.nwfsc.noaa.gov/publications/techmemos/tm27/tm27.htm>.
- CALTRANS. 2002. Biological assessment for the Benicia Martinez Bridge Project for NMFS. Prepared by California Department of Transportation, Sacramento, CA. Prepared for U.S. Department of Transportation. October 2002.
- Chamberlin, J.W., A.N. Kagley, K.L. Fresh, and T.P. Quinn. 2011. Movements of yearling Chinook salmon during the first summer in marine waters of Hood Canal, Washington. *Transactions of the American Fisheries Society*. 140(2): 429–439.
- Crum, L.A., and Y. Mao. 1996. Acoustically enhanced bubble growth at low frequencies and its implications for human diver and marine mammal safety. *The Journal of the Acoustical Society of America*. 99(5): 2898–2907.

Drake, J.S., E.A. Berntson, R.G. Gustafson, E.E. Holmes, P.S. Levin, N. Tolimieri, R.S. Waples, S.M. Sogard, G.D. Williams, and J.M. Cope. 2010. Status review of five rockfish species in Puget Sound, Washington: Bocaccio (*Sebastodes paucispinis*), canary rockfish (*S. pinniger*), yelloweye rockfish (*S. ruberrimus*), greenstriped rockfish (*S. elongatus*), and redstripe rockfish (*S. proriger*). NOAA Technical Memorandum NMFS-NWFSC-108. National Marine Fisheries Service Northwest Fisheries Science Center, Seattle, WA. December 2010. <http://www.nmfs.noaa.gov/pr/pdfs/statusreviews/rockfish.pdf>.

Davis, N.D., M. Fukuwaka, J.L. Armstrong, and K.W. Myers. 2005. Salmon food habits studies in the Bering Sea, 1960 to present. North Pacific Anadromous Fish Commission Technical Report No. 6. 5 pp.

Duffy, E.J. 2003. Early marine distribution and trophic interactions of juvenile salmon in Puget Sound. University of Washington, Seattle. Master's Thesis. 186 pp.

Duffy, E.J. 2009. Factors during early marine life that affect smolt-to-adult survival of ocean-type Puget Sound Chinook salmon (*Oncorhynchus tshawytscha*). University of Washington, Seattle. Doctoral Thesis. 164 pp.

Duffy, E.J., D.A. Beauchamp, N.C. Overman, and R.L Buckley. 2005. Hatchery Scientific Review Group Research Grant Project Annual Report I. Marine Distribution and Trophic Interactions of Juvenile Salmon in Puget Sound: A Synthesis of Trends among Basins. August 29, 2005. 28 pp.

Feist, B.E. 1991. Potential impacts of pile driving on juvenile pink (*Oncorhynchus gorbuscha*) and chum (*O. keta*) salmon behavior and distribution. MS thesis, University of Washington, Seattle, WA.

Feist, B.E., J.J. Anderson, and R. Miyamoto. 1992. *Potential impacts of pile driving on juvenile pink (*Oncorhynchus gorbuscha*) and chum (*O. keta*) salmon behavior and distribution*. Seattle, WA: Fisheries Research Institute, School of Fisheries, and Applied Physics Laboratory, University of Washington.

Fisheries Hydroacoustic Working Group. 2008. Memorandum on agreement in principle for interim criteria for injury to fish from pile driving. California Department of Transportation (CALTRANS) in coordination with the Federal Highway Administration (FHWA). <http://www.wsdot.wa.gov/NR/rdonlyres/4019ED62-B403-489C-AF05-5F4713D663C9/0/InterimCriteriaAgreement.pdf>.

Fresh, K.L., R. Cardwell, and R. Koons. 1981. Food habits of Pacific salmon, baitfish and their potential competitors and predators in the marine waters of Washington, August 1978 to September 1979. Washington State Department of Fisheries, Olympia, WA.

Fujiwara, M., and R.C. Highsmith. 1997. Harpacticoid copepods: potential link between inbound adult salmon and outbound juvenile salmon. *Marine Ecology Progress Series*. 158: 205–216.

- Greene, H.G., T. Wyllie-Echeverria, D. Gunderson, J. Bizzaro, V. Barrie, K.L. Fresh, C. Robinson, D. Cacchione, D. Penttila, M. Hampton, and A. Summers. 2011. Deep-Water Pacific sand lance (*Ammodytes hexapterus*) habitat evaluation and prediction for the Northwest Straits Region - Final Report. Prepared by University of Washington Friday Harbor Laboratories, et al. Prepared for Northwest Straits Commission, Mount Vernon, WA. June 30, 2011.
- Hafner, W., and B. Dolan. 2009. Naval Base Kitsap at Bangor Water Quality. Phase I survey report for 2007–2008. Prepared by Science Applications International Corporation, Bothell, WA. Prepared for BAE Systems Applied Technologies, Inc., Rockville, MD.
- Hammermeister, T., and W. Hafner. 2009. NAVBASE Kitsap Bangor sediment quality investigation: data report. January 2009. Prepared by Science Applications International Corporation, Bothell, WA. Prepared for BAE Systems Applied Technologies, Inc., Bothell, WA.
- Hard, J.J., J.M. Myers, M.J. Ford, R.G. Cope, G.R. Pess, R.S. Waples, G.A. Winans, B.A. Berejikian, F.W. Waknitz, P.B. Adams, P.A. Bisson, D.E. Campton, and R.R. Reisenbichler. 2007. Status review of Puget Sound steelhead (*Oncorhynchus mykiss*). NOAA Tech. Memo. NMFS-NWFSC-81. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Seattle, WA. 117 pp.
http://www.nwfsc.noaa.gov/assets/25/6649_07312007_160715_SRSteelheadTM81Final.pdf
- Hastings, M.C. 2002. Clarification of the meaning of sound pressure levels and the known effects of sound on fish. Supporting document for the Biological Assessment for San Francisco-Oakland Bay Bridge East Span Seismic Safety Project.
- Hastings, M.C., and A.N. Popper. 2005. Effects of sound on fish. Prepared by Jones & Stokes. Prepared for California Department of Transportation, Sacramento, CA.
http://www.dot.ca.gov/hq/env/bio/files/Effects_of_Sound_on_Fish23Aug05.pdf.
- Hastings, M.C., A.N. Popper, J.J. Finneran, and P.J. Lanford. 1996. Effects of low-frequency underwater sound on hair cells of the inner ear and lateral line of the teleost fish *Astronotus ocellatus*. *The Journal of the Acoustical Society of America*. 99(3): 1759–1766.
- Haynes, T.B., C.K.L. Robinson, and P. Dearden. 2008. Modelling nearshore intertidal habitat use of young-of-the-year Pacific sand lance (*Ammodytes hexapterus*) in Barkley Sound, British Columbia, Canada. *Environmental Biology of Fishes*. 83(4): 473–484.
- HCCC (Hood Canal Coordinating Council). 2005. DRAFT Hood Canal/Eastern Strait of Juan de Fuca Summer Chum Salmon Recovery Plan. Hood Canal Coordinating Council, Poulsbo, WA. November 15, 2005. <http://www.nwr.noaa.gov/Salmon-Recovery-Planning/Recovery-Domains/Puget-Sound/HC-Recovery-Plan.cfm>.
- Healey, M.C. 1982. Juvenile Pacific salmon in estuaries: The life support system. In *Estuarine Comparisons*. Kennedy, V.S. New York, NY: Academic Press. 315–341.
- Healey, M.C. 1991. Life history of Chinook salmon (*Oncorhynchus tshawytscha*). In *Pacific salmon life histories*, ed. Groot, C. and L. Margolis. Vancouver: University of British Columbia Press. 311–394.

- Heard, W.R. 1991. Life History of pink salmon (*Oncorhynchus gorbuscha*). In Groot, C., and L. Margolis (Eds.) *Pacific Salmon Life Histories*. UBC Press, University of British Columbia, Vancouver, Canada. 121–230.
- Hirschi, R., T. Doty, A. Keller, and T. Labbe. 2003. Juvenile salmonid use of tidal creek and independent marsh environments in North Hood Canal: summary of first year findings. Port Gamble S'Klallam Tribe, Kingston, WA.
- Holmberg, E.K., G.S. DiDonato, N. Pasquale, and R.E. Laramie. 1962. Research report on the Washington trawl fishery 1960 and 1961. Washington Department of Fisheries, Research Division. Technical Report, unpublished.
- Hood Canal Dissolved Oxygen Program. 2009. Hood Canal Salmon Enhancement Group Citizen's Monitoring Program dissolved oxygen data for the Bangor West, Central, and East sampling stations. http://www.hoodcanal.washington.edu/observations/cm_time_series.jsp (Accessed January 29, 2009)
- Hubbs, C.L., and A.B. Rechnitzer. 1952. Report on experiments designed to determine effects of underwater explosions on fish life. *California Fish and Game*. 38(3): 333–365.
- Johnson, O.W., W.S. Grant, R.G. Kope, K. Neely, F.W. Waknitz, and R.S. Waples. 1997. Status review of chum salmon from Washington, Oregon, and California. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-32, 280 pp.
- Johnson, O.W., M.H. Ruckelshaus, W.S. Grant, F.W. Waknitz, A.M. Garrett, G.J. Bryant, K. Neely, and J.J. Hard. 1999. Status review of coastal cutthroat trout from Washington, Oregon, and California. NOAA Technical Memorandum NMFS-NWFSC-37.
- Johnson, T. 2006. Thom Johnson, Fisheries Biologist, Washington State Department of Fish and Wildlife. December 6, 2006. Personal communication with Alison Agness, Marine Biologist, Science Applications International Corporation, Bothell, WA, re: Steelhead stocks in Hood Canal.
- Kincaid, T. 1919. *An annotated list of Puget Sound fishes*. Olympia: Washington Department of Fisheries.
- Levy, D.A., and T.G. Northcote. 1982. Juvenile salmon residency in a marsh area of the Fraser River Estuary. *Canadian Journal of Fisheries and Aquatic Sciences*. 39: 270–276.
- Love, M.S., M. Yoklavich, and L.K. Thorsteinson. 2002. The rockfishes of the northeast Pacific. Berkeley: University of California Press.
- Miller, B.S., and S.F. Borton. 1980. *Geographical distribution of Puget Sound fishes: maps and data source sheets*. Vol. 2: Family Percichthyidae (Temperate Basses) through Family Hexagrammidae (greenlings). Seattle, WA: Fisheries Research Institute, College of Fisheries, University of Washington.
- Mumford, T.F. 2007. Kelp and eelgrass in Puget Sound. Puget Sound Nearshore Partnership Report No. 2007-05. Seattle District, U.S. Army Corps of Engineers, Seattle, WA.

- Nedwell, J.R., A.W.H. Turnpenny, J.M. Lovell, and B. Edwards. 2006. An investigation into the effects of underwater piling noise on salmonids. *The Journal of the Acoustical Society of America*. 120(5): 2550–2554.
- Nightingale, B., and C.A. Simenstad. 2001a. Overwater structures: Marine issues. Prepared by University of Washington, Wetland Ecosystem Team, School of Aquatic and Fishery Sciences. Prepared for Washington Department of Fish and Wildlife, Washington Department of Ecology, Washington Department of Transportation, Seattle, WA. 181 pp.
- Nightingale, B., and C.A. Simenstad. 2001b. Dredging Activities: Marine Issues white paper. Prepared by University of Washington, Wetland Ecosystem Team, School of Aquatic and Fishery Sciences. Prepared for Washington Department of Fish and Wildlife, Washington State Department of Ecology and Washington Department of Transportation. July 13, 2001. <http://wdfw.wa.gov/hab/ahg/finaldrg.pdf>
- NMFS (National Marine Fisheries Service). 1996. Making Endangered Species Act Determinations of Effect for Individual or Grouped Actions at the Watershed Scale. Environmental and Technical Services Division, Habitat Conservation Branch.
- NMFS. 1999. The habitat approach: implementation of Section 7 of the Endangered Species Act for actions affecting the habitat of Pacific anadromous salmonids. Memo for NMFS/NWR Staff. National Marine Fisheries Service Northwest Region Habitat Conservation and Protected Resources Divisions. August 26, 1999. http://www.nwr.noaa.gov/Publications/Reference-Documents/upload/habitatapproach_081999-2.pdf
- NMFS. 2005a. Status review update for Puget Sound steelhead. Puget Sound Steelhead Biological Review Team, National Marine Fisheries Service, Northwest Fisheries Science Center, Seattle, WA. 26 July 2005. 114 pp. <http://www.nwr.noaa.gov/Publications/Biological-Status-Reviews/upload/SR2005-steelhead.pdf>.
- NMFS. 2005b. Final Environmental Impact Statement for Essential Fish Habitat identification and conservation in Alaska. Appendix G. Non-fishing impacts to EFH and recommended conservation measures. National Marine Fisheries Service, Alaska Region, Juneau, AK. April 2005. http://www.fakr.noaa.gov/habitat/seis/final/Volume_II/Appendix_G.pdf.
- NMFS. 2011. 5-Year Review: Summary & Evaluation of Puget Sound Chinook, Hood Canal Summer Chum, Puget Sound Steelhead. National Marine Fisheries Service, Northwest Region, Portland, OR. Approved July 26, 2011. http://www.nwr.noaa.gov/publications/status_reviews/salmon_steelehead/multiple_species/5-yr-ps.pdf.
- NWFSC (Northwest Fisheries Science Center). 2013. *Salmon population trend summaries*. Northwest Fisheries Science Center, Seattle, WA (Accessed August 26, 2013). http://www.nwfsc.noaa.gov/trt/pubs_esu_trend.cfm
- Pacific States Marine Fisheries Commission. 1996. Coastal cutthroat trout. Last revised December 19, 1996. http://www.psmfc.org/habitat/edu_anadcutfthroat_facts.html (Accessed June 12, 2008)

- Palsson, W.A., T.-S. Tsou, G.G. Bargmann, R.M. Buckley, J.E. West, M.L. Mills, Y.W. Cheng, and R.E. Pacunski. 2009. The biology and assessment of rockfishes in Puget Sound. FPT 09-04. Fish Management Division, Fish Program, Washington Department of Fish and Wildlife, Olympia, WA. September 2009. <http://wdfw.wa.gov/publications/00926/wdfw00926.pdf>.
- Pauley, G.B., B.M. Bortz, and M.F. Shepard. 1986. Species profiles: life histories and environmental requirements of coastal fishes and invertebrates (Pacific Northwest) – steelhead trout. U.S. Fish Wildl. Serv. Biol. Rep. 82(11.62). USACE, TR EL-82-4. 24 pp.
- Pauley, G.B., K.L. Bowers, and G.L. Thomas. 1988. Species profiles: life histories and environmental requirements of coastal fishes and invertebrates (Pacific Northwest) – chum salmon. U.S. Fish Wildl. Serv. Biol. Rep. 82(11.81) U.S. Army Corps of Engineers, TR EL-82-4. 17 pp.
- Pauley, G.B., R. Risher, and G.L. Thomas. 1989. Species Profile: Life histories and environmental requirements of coastal fishes and invertebrates (Pacific Northwest) – Sockeye salmon. USFWS Biol. Rep 82(11.116) USACE, TR EL-82-4. 22 pp.
- Pearson, W.H., J.R. Skalski, and C.I. Malme. 1992. Effects of sounds from a geophysical survey device on behavior of captive rockfish (*Sebastodes* spp.). *Canadian Journal of Fisheries and Aquatic Sciences*. 49: 1343–1355.
- Penttila, D.E. 1997. Newly documented spawning beaches of the surf smelt (*Hypomesus*) and the Pacific sand lance (*Ammodytes*) in Washington State, May 1996 through June 1997. Manuscript Report. Marine Resource Division, Washington Department of Fish and Wildlife.
- Penttila, D.E. 1999. Documented spawning beaches of the surf smelt (*Hypomesus*) and the Pacific sand lance (*Ammodytes*) in Hood Canal, Washington. Manuscript Report. Marine Resource Division, Washington Department of Fish and Wildlife.
- Penttila, D.E. 2007. Marine forage fishes in Puget Sound. Puget Sound Nearshore Partnership Report No. 2007-03. Seattle District, U.S. Army Corps of Engineers, Seattle, WA.
- Phillips, C., B. Dolan, and W. Hafner. 2009. Water Quality along the Naval Base Kitsap at Bangor shorelines. Phase I survey report for 2005-2006. Prepared by Science Applications International Corporation, Bothell, WA. Prepared for BAE Systems Applied Technologies, Inc., Rockville, MD.
- Popper, A.N., T.J. Carlson, A.D. Hawkins, B.L. Southall, and R.L. Gentry. 2006. Interim criteria for injury of fish exposed to pile driving operations: A white paper. http://www.wsdot.wa.gov/NR/rdonlyres/84A6313A-9297-42C9-BFA6-750A691E1DB3/0/BA_PileDrivingInterimCriteria.pdf.
- Popper, A.N., and M.C. Hastings. 2009. The effects of anthropogenic sources of sound on fishes. *Journal of Fish Biology*. 75: 455–489.
- Prinslow, T.E., C.J. Whitmus, J.J. Dawson, N.J. Bax, B.P. Snyder, and E.O. Salo. 1980. Effects of wharf lighting on outmigrating salmon, 1979. Final report, January to December 1979.

Prepared by Fisheries Research Institute and University of Washington, Seattle, WA.
Prepared for U.S. Department of the Navy, Silverdale, WA. 137 pp.

Quinn, T. 1999. Habitat characteristics of an intertidal aggregation of Pacific sandlance (*Ammodytes hexapterus*) at a North Puget Sound beach in Washington. *Northwest Science*. 73(1): 44–49.

Quinn, T.P. 2005. The Behavior and Ecology of Pacific Salmon and Trout. University of Washington Press, Seattle, WA.

Redman, S., D. Myers, and D. Averill. 2005. Regional Nearshore and Marine Aspects of Salmon Recovery in Puget Sound. Prepared for Shared Strategy for Puget Sound for inclusion in their regional salmon recovery plan. June 28, 2005. 321 pp.

Rohde, J.A. 2013. Partial migration of Puget Sound Coho salmon (*Oncorhynchus kisutch*) individual and population level patterns. Master of Science Thesis, University of Washington, Seattle, WA. <http://faculty.washington.edu/tquinn/pubs/thesis.pdf>.

Ruggerone, G. 2006. Dr. Greg Ruggerone, Ph.D. Senior Fisheries Biologist, Natural Resource Consultants, Seattle, WA. May 8, 2006. Personal communication with Chris Hunt, Marine Biologist, Science Applications International Corporation, Bothell, WA, re: The presence of a juvenile sockeye salmon captured in Hood Canal likely coming from abundant Fraser River stocks rather than from the nearby, yet less abundant Lake Washington stocks.

Ruggerone, G.T., S.E. Goodman, and R. Miner. 2008. Behavioral response and survival of juvenile coho salmon to pile driving sounds. Natural Resources Consultants, Inc., and Robert Miner Dynamic Testing, Inc. Prepared for Port of Seattle, Seattle, WA.

SAIC. 2006. Naval Base Kitsap-Bangor fish presence and habitat use. Combined phase I and II field survey report (Draft). Prepared by Science Applications International Corporation, Bothell, WA. Prepared for BAE Systems Applied Technologies, Inc., Rockville, MD.

SAIC. 2009. Naval Base Kitsap At Bangor Comprehensive Eelgrass Survey Field Survey Report. Prepared by Science Applications International Corporation, Bothell, WA. Prepared for BAE Systems Applied Technologies, Inc., Rockville, MD.

Salo, E.O. 1991. Life history of chum salmon (*Oncorhynchus keta*). In *Pacific salmon life histories*. Groot, C. and L. Margolis. Vancouver: University of British Columbia Press. 231–310.

Salo, E.O., N.J. Bax, T.E. Prinslow, C.J. Whitmus, B.P. Snyder, and C.A. Simenstad. 1980. The effects of construction of Naval facilities on the outmigration of juvenile salmonids from Hood Canal, Washington. Final report. Prepared by Fisheries Research Institute, College of Fisheries, University of Washington. Prepared for U.S. Navy, OICC Trident, Seattle, WA. 159 pp.

Sandercok, F.K. 1991. Life history of coho salmon (*Oncorhynchus kisutch*). In *Pacific salmon life histories*. K. Groot and L. Margolis, eds. Vancouver, British Columbia: UBC Press. 396–445.

- Schreiner, J.U. 1977. Salmonid outmigration studies in Hood Canal, Washington. M.S. thesis, University of Washington, Seattle, WA.
- Schreiner, J.U., E.O. Salo, B.P. Snyder, and C.A. Simenstad. 1977. Salmonid outmigration studies in Hood Canal. Final report, Phase II. FRI-UW-7715. Prepared by Fisheries Research Institute, College of Fisheries, University of Washington. Prepared for U.S. Department of the Navy, Seattle, WA. 64 pp.
- Shafer, D.J. 2002. Recommendations to minimize potential impacts to seagrasses from single-family residential dock structures in the Pacific Northwest. U.S. Army Corps of Engineers, Seattle District. Engineer Research and Development Center, Seattle, WA.
- Shepard, M.F. 1981. Status review of the knowledge pertaining to the estuarine habitat requirement and life history of Chum and Chinook salmon juveniles in Puget Sound, Washington. Cooperative Fishery Research Unit, College of Fisheries, University of Washington, Seattle, WA.
- Simenstad, C.A., and J.R. Cordell. 2000. Ecological assessment criteria for restoring anadromous salmonid habitat in Pacific Northwest Estuaries. *Ecological Engineering*. 15: 283–302.
- Simenstad, C.A., B.J. Nightingale, R.M. Thom, and D.K. Shreffler. 1999. Impacts of ferry terminals on juvenile salmon migrating along Puget Sound shorelines: Phase I: Synthesis of state of knowledge. Prepared by Washington State Transportation Center (TRAC). Prepared for Washington State Transportation Commission in cooperation with the U.S. Department of Transportation, Olympia, WA. <http://depts.washington.edu/trac/bulkdisk/pdf/472.1.pdf>.
- Simenstad, C.A., R.M. Thom, K.A. Kuzis, J.R. Cordell, and D.K. Shreffler. 1988. Nearshore community studies of Neah Bay, Washington. FRI-UW-8811. Prepared by Wetland Ecosystem Team, Fisheries Research Institute, School of Fisheries, University of Washington. Prepared for U.S. Army Corps of Engineers, Seattle District, Environmental Resources Section, Seattle, WA. June 1988.
- Skalski, J.R., W.H. Pearson, and C.I. Malme. 1992. Effects of sounds from a geophysical survey device on catch-per-unit-effort in a hook-and-line fishery for rockfish (*Sebastodes* spp.). *Canadian Journal of Fisheries and Aquatic Sciences*. 49: 1357–1365.
- Slotte, A., K. Hansen, J. Dalen, and E. Ona. 2004. Acoustic mapping of pelagic fish distribution and abundance in relation to a seismic shooting area off the Norwegian west coast. *Fisheries Research*. 67(2): 143–150.
- Stadler 2002 personal observation. [Cited in the Test Pile Program Biological Assessment but the complete citation was not included in the reference section of the BA; Navy requested to provide this reference so that this citation can be completed and for inclusion in the Administrative Record.]
- Stick, K.C., and A. Lindquist. 2009. 2008 Washington State herring stock status report. Stock Status Report No. FPA 09-05. Washington Department of Fish and Wildlife Fish Program, Fish Management Division, Olympia, WA. November 2009.

- Stroetz, R.W., N.E. Vlahakis, B.J. Walters, M.A. Schroeder, and R.D. Hubmayr. 2001. Validation of a new live cell strain system: characterization of plasma membrane stress failure. *Journal of Applied Physiology*. 90(6): 2361–2370.
- Tagal, M., K.C. Massee, N. Ashton, R. Campbell, P. Pleasha, and M.B. Rust. 2002. Larval development of yelloweye rockfish, *Sebastodes ruberrimus*. National Oceanic and Atmospheric Administration, Northwest Fisheries Science Center.
- Turnpenny, A.W.H., K.P. Thatcher, and J.R. Nedwell. 1994. The effects on fish and other marine animals of high-level underwater sound. Fawley Aquatic Research Laboratory, Ltd., Report FRR 127/94, United Kingdom. October 1994.
- Tynan, T. J. 1997. Life history characterization of summer chum salmon populations in the Hood Canal and eastern Strait of Juan de Fuca regions. Tech. Report # H97-06. Hatcheries Program, Wash. Dept. Fish and Wildlife, Olympia. 99 pp.
- USFWS (U.S. Fish and Wildlife). 2010. Biological Opinion for the United States Commander, U.S. Pacific Fleet Northwest Training Range Complex (NWTRC) in the Northern Pacific Coastal Waters off the States of Washington, Oregon and California and activities in Puget Sound and Airspace over the State of Washington, USA. U.S. Fish and Wildlife Service Washington Fish and Wildlife Office, Lacey, WA. August 12, 2010.
- Vlahakis, N.E., and R.D. Hubmayr. 2000. Invited review: plasma membrane stress failure in alveolar epithelial cells. *Journal of Applied Physiology*. 89(6): 2490–2496.
- Wardle, C.S., T.J. Carter, G.G. Urquhart, A.D.F. Johnstone, A.M. Ziolkowski, G. Hampson, and D. Mackie. 2001. Effects of seismic air guns on marine fish. *Continental Shelf Research*. 21(8): 1005–1027.
- Washington Department of Fisheries, Washington Department of Wildlife, and Western Washington Treaty Indian Tribes. 1993. 1992 Washington State salmon and steelhead stock inventory (SASSI). Washington Department of Fisheries, Olympia, WA. 212 pp.
- WDFW (Washington Department of Wildlife). 2002. Salmonid stock inventory (SaSI) 2002. Maps and stock reports. Washington Department of Fish and Wildlife, Olympia, WA. <http://wdfw.wa.gov/fish/sasi/>.
- WDFW. 2004. Washington State salmonid stock inventory. Bull trout/Dolly Varden. Washington Department of Fish and Wildlife, Olympia, WA. 449 pp. <http://wdfw.wa.gov/fish/sassi/bulldolly.pdf>.
- WDFW. 2013. *SalmonScape interactive online mapping application for Pacific sand lance spawning grounds at NAVBASE Kitsap Bangor, Washington*. <http://fortress.wa.gov/dfw/gispublic/apps/salmonscape/default.htm> (Accessed March 23, 2013).
- WDFW and PNPTT. 2000. Summer chum salmon conservation initiative: An implementation plan to recover summer chum in the Hood Canal and Strait of Juan de Fuca Region. Report for WDFW and Point-No-Point Treaty Tribes. Washington Department of Fish and Wildlife, Olympia, WA. <http://wdfw.wa.gov/fish/chum.htm>.

- Webb, D.G. 1991a. Effect of predation by juvenile Pacific salmon on marine harpacticoid copepods. 1. Comparisons of patterns of copepod mortality with patterns of salmon consumption. *Marine Ecology Progress Series*. 72: 25–36.
- Webb, D.G. 1991b. Effect of predation by juvenile Pacific salmon on marine harpacticoid copepods. 2. Predator density manipulation experiments. *Marine Ecology Progress Series*. 72: 37–47.
- Weinheimer, J. 2013. Mid-Hood Canal juvenile salmonid evaluation: Duckabush and Hamma Hamma 2012. FPA 13-04. Washington Department of Fish and Wildlife, Fish Program, Science Division, Wild Salmon Production/Evaluation, Olympia, WA. August 2013. <http://wdfw.wa.gov/publications/01536/wdfw01536.pdf>.
- Weitkamp, D., G. Ruggerone, L. Sacha, J. Howell, and B. Bachen. 2000. Factors affecting Chinook populations. Background report. Prepared by Parametrix Inc., Natural Resources Consultants, and Cedar River Associates. Prepared for City of Seattle, Seattle, WA.
- Weitkamp, L.A., T.C. Wainwright, G.J. Bryant, G.B. Milner, D.J. Teel, R.G. Kope, and R.S. Waples. 1995. Status review of coho salmon from Washington, Oregon, and California. NOAA Technical Memorandum NMFS-NWFSC-24. Seattle, Washington. <http://www.nwfsc.noaa.gov/publications/techmemos/tm24/tm24.htm>
- Yelverton, J.T., D.R. Richmond, W. Hicks, K. Saunders, and R.E. Fletcher. 1975. The relationship between fish size and their response to underwater blast. DNA 3677T. Prepared by Lovelace Foundation for Medical Education and Research, Albuquerque, NM. Prepared for Defense Nuclear Agency, Washington, DC. June 18, 1975.

APPENDIX C

MITIGATION ACTION PLAN

MITIGATION ACTION PLAN

LAND-WATER INTERFACE
AND
SERVICE PIER EXTENSION
AT NAVAL BASE KITSAP BANGOR

NAVAL BASE KITSAP BANGOR
SILVERDALE, WA

January 2015

DEPARTMENT OF THE NAVY

This page is intentionally blank.

EXECUTIVE SUMMARY

This document presents a Mitigation Action Plan for the proposed construction and operation of two proposed actions on Naval Base Kitsap Bangor (NAVBASE Kitsap Bangor), Washington: the Land-Water Interface (LWI) and the Service Pier Extension (SPE).

Aspects of these two proposed actions have the potential to cause environmental impacts. Several measures, including current practices (CPs), best management practices (BMPs), and mitigation measures (MMs), will be applied to the project to avoid, reduce, and mitigate the effects from this action.

Project measures include the following:

- BMPs to ensure compliance with the United States Environmental Protection Agency's (USEPA) general permit for stormwater discharges from construction sites;
- CPs to minimize the potential for impacts during construction and operational phases of the project;
- Noise attenuation measures during construction, including bubble curtains and soft start for impact pile drivers;
- Monitoring to minimize noise impacts;
- Mitigation measures for biological, cultural, and other resources; and
- Compensatory aquatic mitigation.

These measures are in addition to project compliance with all applicable regulations or permit conditions. The Department of the Navy (Navy) ultimately will be responsible for ensuring agreed-upon measures are implemented.

Measures are described in Sections 2 through 5 of this Mitigation Action Plan. For each category of CPs, BMPs, and MMs, the Mitigation Action Plan provides (1) description of the measure; (2) parties responsible for implementation; (3) planned implementation schedule; (4) planned funding; (5) mitigation-specific performance criteria; (6) monitoring and tracking mechanisms; and (7) enforcement measures. Section 6 of this Mitigation Action Plan describes the Navy's proposed Compensatory Mitigation action, which would offset unavoidable adverse impacts on other aquatic resources. Mitigation measures will be documented in the Records of Decision (ROD) for the two proposed actions.

This page is intentionally blank.

TABLE OF CONTENTS

EXECUTIVE SUMMARY	C-i
1.0 INTRODUCTION.....	C-1
1.1. PROPOSED ACTION	C-4
1.2. SCHEDULE	C-12
1.3. COMPENSATORY AQUATIC MITIGATION	C-12
1.4. MONITORING AND REPORTING PROCEDURES	C-12
1.5. MITIGATION MONITORING AND REPORTING PROGRAM IMPLEMENTATION	C-13
1.6. ADAPTIVE MANAGEMENT	C-13
2.0 CURRENT AND BEST MANAGEMENT PRACTICES	C-15
2.1. PROTECTION OF MARINE WATER QUALITY AND SEAFLOOR DURING CONSTRUCTION.....	C-15
2.1.1. Potential Impacts	C-15
2.1.2. Environmental Protection Measures.....	C-15
2.1.2.1. Stormwater Pollution Prevention Plan (BMP 1).....	C-15
2.1.2.2. Spill Prevention Control Measure (CP 1a).....	C-17
2.1.2.3. Construction Debris and pile removal Control Measures (CP 1b).....	C-18
2.1.2.4. Prop Wash Control Measure (CP 1c).....	C-20
2.1.2.5. Work Vessel Grounding Control Measure (CP 1d)	C-20
2.1.2.6. Mooring and Anchoring Plan (CP 1e)	C-21
2.2. IN-WATER WORK WINDOW (MM 2).....	C-22
2.2.1. Potential Impacts	C-22
2.2.2. Mitigation Measures (MM 2)	C-22
2.2.3. Party(ies) Responsible for Implementation	C-23
2.2.4. Planned Implementation Schedule	C-23
2.2.5. Planned Funding.....	C-23
2.2.6. Mitigation-Specific Performance Criteria	C-23
2.2.7. Monitoring and Tracking Mechanisms.....	C-23
2.2.8. Enforcement Measures	C-23
2.3. PROTECTION OF UPLAND WATER QUALITY DURING CONSTRUCTION (BMP 3)	C-23
2.3.1. Potential Impacts	C-23
2.3.2. Mitigation Measures.....	C-23
2.3.2.1. Implement SWPPP (BMP 3).....	C-23
2.3.3. Party(ies) Responsible for Implementation	C-24
2.3.4. Planned Implementation Schedule	C-24
2.3.5. Planned Funding.....	C-24
2.3.6. Mitigation-Specific Performance Criteria	C-24
2.3.7. Monitoring and Tracking Mechanisms.....	C-24
2.3.8. Enforcement Measures	C-24
2.4. PROTECTION OF WATER QUALITY DURING OPERATIONS.....	C-25
2.4.1. Potential Impacts	C-25
2.4.2. Mitigation Measures.....	C-25
2.4.2.1. Integrated SWPPP (BMP 4).....	C-25
2.4.2.2. Low Impact Development (CP 4a)	C-26
2.4.2.3. Oil and Hazardous Spill Contingency (CP 4b)	C-26
2.4.3. Party(ies) Responsible for Implementation	C-26
2.4.4. Planned Implementation Schedule	C-26
2.4.5. Planned Funding.....	C-26
2.4.6. Mitigation-Specific Performance Criteria	C-27
2.4.7. Monitoring and Tracking Mechanisms.....	C-27
2.4.8. Enforcement Measures	C-27
3.0 NOISE ATTENUATION DURING CONSTRUCTION	C-29
3.1. POTENTIAL IMPACTS	C-29
3.2. MITIGATION MEASURES.....	C-29
3.2.1. Use of Vibratory Driver in Lieu of Impact Hammer (MM 5a)	C-29

3.2.1.1.	Description	C-29
3.2.1.2.	Party(ies) Responsible for Implementation.....	C-29
3.2.1.3.	Planned Implementation Schedule.....	C-29
3.2.1.4.	Planned Funding.....	C-29
3.2.1.5.	Mitigation-Specific Performance Criteria.....	C-29
3.2.1.6.	Monitoring and Tracking Mechanisms.....	C-30
3.2.1.7.	Enforcement Measures	C-30
3.2.2.	Deploy Air Bubble Curtains or Other Noise Attenuating Device(s) for Impact Hammer Operations (MM 5b)	C-30
3.2.2.1.	Description	C-30
3.2.2.2.	Party(ies) Responsible for Implementation.....	C-30
3.2.2.3.	Planned Implementation Schedule.....	C-30
3.2.2.4.	Planned Funding.....	C-30
3.2.2.5.	Mitigation-Specific Performance Criteria.....	C-30
3.2.2.6.	Monitoring and Tracking Mechanisms.....	C-30
3.2.2.7.	Enforcement Measures	C-30
3.2.3.	Soft Start for Pile Driver Operations (MM 5c).....	C-31
3.2.3.1.	Description	C-31
3.2.3.2.	Party(ies) Responsible for Implementation.....	C-31
3.2.3.3.	Planned Implementation Schedule.....	C-31
3.2.3.4.	Planned Funding.....	C-31
3.2.3.5.	Mitigation-Specific Performance Criteria.....	C-31
3.2.3.6.	Monitoring and Tracking Mechanisms.....	C-32
3.2.3.7.	Enforcement Measures	C-32
3.2.4.	Timing Restrictions (MM 5d).....	C-32
3.2.4.1.	Description	C-32
3.2.4.2.	Party(ies) Responsible for Implementation.....	C-32
3.2.4.3.	Planned Implementation Schedule.....	C-32
3.2.4.4.	Planned Funding.....	C-32
3.2.4.5.	Mitigation-Specific Performance Criteria.....	C-32
3.2.4.6.	Monitoring and Tracking Mechanisms.....	C-32
3.2.4.7.	Enforcement Measures	C-33
4.0	MONITORING TO MINIMIZE NOISE IMPACTS.....	C-35
4.1.	POTENTIAL IMPACTS.....	C-35
4.2.	MITIGATION MEASURES	C-35
4.2.1.	Monitoring Plans	C-35
4.2.1.1.	Marine Mammal and Marbled Murrelet Visual Monitoring (MM 6).....	C-36
4.2.1.2.	Reporting	C-43
4.2.1.3.	Interagency Notification	C-43
4.3.	PARTY(IES) RESPONSIBLE FOR IMPLEMENTATION	C-44
4.4.	PLANNED IMPLEMENTATION SCHEDULE.....	C-44
4.5.	PLANNED FUNDING	C-44
4.6.	MITIGATION-SPECIFIC PERFORMANCE CRITERIA	C-44
4.7.	MONITORING AND TRACKING MECHANISMS	C-44
4.8.	ENFORCEMENT MEASURES.....	C-44
5.0	MITIGATION MEASURES FOR BIOLOGICAL, CULTURAL, AND OTHER RESOURCES	C-45
5.1.	MITIGATION MEASURES FOR OTHER BIOLOGICAL IMPACTS	C-45
5.1.1.	Potential Impacts	C-45
5.1.2.	Mitigation Measures	C-45
5.1.3.	Party(ies) Responsible for Implementation	C-46
5.1.4.	Planned Implementation Schedule.....	C-46
5.1.5.	Planned Funding	C-46
5.1.6.	Mitigation-Specific Performance Criteria	C-46
5.1.7.	Monitoring and Tracking Mechanisms	C-47
5.1.8.	Enforcement Measures	C-47
5.2.	MITIGATION MEASURES FOR CULTURAL RESOURCES IMPACTS	C-47
5.2.1.	Potential Impacts	C-47

5.2.2.	Mitigation Measures (MM 9)	C-47
5.2.3.	Party(ies) Responsible for Implementation	C-47
5.2.4.	Planned Implementation Schedule	C-47
5.2.5.	Planned Funding.....	C-47
5.2.6.	Mitigation-Specific Performance Criteria	C-48
5.2.7.	Monitoring and Tracking Mechanisms.....	C-48
5.2.8.	Enforcement Measures	C-48
5.3.	OTHER RESOURCES	C-48
5.3.1.	Geology and Soils	C-48
5.3.2.	Noise	C-48
5.3.3.	Air Quality	C-49
5.3.4.	Land Use and Recreation	C-49
5.3.5.	Aesthetics	C-49
5.3.6.	Socioeconomics.....	C-49
5.3.7.	Traffic.....	C-50
5.3.7.1.	Notice to Mariners (MM 11a).....	C-50
5.3.7.2.	Barge Traffic (MM 11b)	C-50
6.0	COMPENSATORY AQUATIC MITIGATION (MM 12).....	C-51
6.1.	INTRODUCTION.....	C-51
6.2.	REGULATORY OVERVIEW.....	C-51
6.3.	SUMMARY OF IMPACTS REQUIRING COMPENSATORY MITIGATION.....	C-52
6.4.	HOOD CANAL IN-LIEU FEE PROGRAM.....	C-55
6.4.1.	ILF Program Goal and Objectives.....	C-55
6.4.2.	Hood Canal ILF Service Area	C-56
6.4.3.	Navy's Use of the HCCC ILF Program	C-56
7.0	PERMITTING AND CONSULTATION TERMS AND CONDITIONS	C-59
8.0	SUMMARY OF PROPOSED MEASURES TO AVOID, MINIMIZE, AND COMPENSATE FOR ENVIRONMENTAL IMPACTS ON AQUATIC RESOURCES.....	C-61
8.1.	HYDROGRAPHY	C-61
8.2.	MARINE WATER QUALITY	C-62
8.3.	EELGRASS	C-62
8.4.	BENTHIC COMMUNITY	C-63
8.5.	MARINE FISH.....	C-63
8.6.	MARINE MAMMALS AND BIRDS	C-63
9.0	TRIBAL MITIGATION.....	C-65
10.0	LIST OF PREPARERS	C-67
11.0	LITERATURE CITED.....	C-69

LIST OF ATTACHMENTS

- Attachment A Seabird Monitoring Data Collection Form
Attachment B Beaufort Wind Scale
Attachment C Chain of Custody Record Form

LIST OF FIGURES

Figure 1.	Vicinity Map	C-2
Figure 2.	Location of the LWI and SPE Projects.....	C-3
Figure 3.	Intertidal and Subtidal Zones	C-57

LIST OF TABLES

Table 1.	Summary of Mitigation Measures for the LWI and SPE Projects.....	C-5
Table 2.	Compensatory Mitigation for LWI Impacts on Aquatic Habitat and Waters of the U.S.....	C-53
Table 3.	Compensatory Mitigation for SPE Impacts on Aquatic Habitat and Waters of the U.S.	C-54

LIST OF ACRONYMS AND ABBREVIATIONS

BMP	best management practice
BSS	Beaufort Sea State
CCD	Coastal Consistency Determination
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
COMNAVREGNWINST	Commander Navy Region Northwest Instruction
CP	current practice
CWA	Clean Water Act
CZMA	Coastal Zone Management Act
dB	decibel
dBA	A-weighted decibel
dB re 1µPa	decibels referenced at 1 micropascal
DoD	Department of Defense
EIS	Environmental Impact Statement
EISA	Energy Independence and Security Act
ESA	Endangered Species Act
GPS	Global Positioning System
HCCC	Hood Canal Coordinating Council
Hz	hertz
ILF	In-lieu fee
IMP	integrated management practices
JARPA	Joint Aquatic Resource Permits Application
kHz	kilohertz
LID	low impact development
LWI	Land-Water Interface
MBTA	Migratory Bird Treaty Act
MHHW	mean higher high water
MLLW	mean lower low water
MM	mitigation measure
MMO	marine mammal observer
MMPA	Marine Mammal Protection Act
MOA	Memorandum of Agreement
MSGP	Multi-Sector General Permit
NAVBASE	Naval Base
NAVFAC NW	Naval Facilities Engineering Command Northwest
Navy	Department of the Navy
NHPA	National Historic Preservation Act
NMFS	National Marine Fisheries Service
NOI	Notice of Intent
NPDES	National Pollutant Discharge Elimination System
OPNAVINST	Chief of Naval Operations Instruction
OSHA	Occupational Safety and Health Administration
PSB	Port Security Barrier
RMS	root mean square
ROD	Record of Decision
SEL	sound exposure level
SHPO	State Historic Preservation Officer
SPE	Service Pier Extension

LIST OF ACRONYMS AND ABBREVIATIONS

SPL	sound pressure level
SSBN	OHIO Class Ballistic Missile submarine
SR	State Route
SWPPP	storm water pollution prevention plan
TRIDENT	TRIDENT Fleet Ballistic Missile
TTS	temporary threshold shift
USACE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
WAC	Washington Administrative Code
WDOE	Washington Department of Ecology
WRA	Waterfront Restricted Area

1.0 INTRODUCTION

This document presents the Department of the Navy's (Navy's) Mitigation Action Plan for two proposed actions on Naval Base (NAVBASE) Kitsap Bangor, Washington: the Land-Water Interface (LWI) and the Service Pier Extension (SPE). NAVBASE Kitsap Bangor, Washington, is located on Hood Canal approximately 20 miles due west of Seattle, Washington (Figure 1). The project sites for the LWI are located on the perimeter of the Waterfront Restricted Area (WRA) at the Bangor waterfront. Access to this portion of the Bangor waterfront is restricted by a fencing system on the land and a floating barrier system on the water. The Service Pier is not located within the WRA but is within the floating barrier system, which extends beyond the WRA (Figure 2). Both project sites are within the Hood Canal hydrologic unit code 17110018 and the Water Resource Inventory Area 15 (Kitsap County).

As recognized by the Council on Environmental Quality (CEQ) in their Memorandum about the appropriate use of mitigation and monitoring (CEQ 2011), mitigation is an important mechanism that federal agencies can use to minimize potential adverse environmental impacts associated with their actions. The term mitigation includes avoiding, minimizing, rectifying and reducing impacts, as well as compensating for impacts. Federal agencies rely upon the expertise of professional staff to assess mitigation needs, develop mitigation plans, and oversee mitigation implementation. Agencies may also rely on outside resources and experts to develop appropriate monitoring strategies and to ensure mitigation has the desired effects.

The mitigation measures detailed in this Mitigation Action Plan were developed through a multi-disciplinary approach. Input from environmental professionals from the Navy, agencies, tribes, and private industry influenced the project design; this will result in an action that would avoid and minimize environmental impacts to the maximum extent possible, while still meeting the Navy's mission requirements. Measures to minimize species impacts were developed through consultation with federal resource agency experts. The Navy's proposed compensatory aquatic mitigation alternatives were developed through an extensive mitigation evaluation and selection process that included federal agencies, tribes, state agencies, local governments, and non-governmental organizations; these efforts are further detailed in Section 6.0 of this Mitigation Action Plan.

CEQ guidance recommends that agencies not commit to mitigation unless they have sufficient legal authorities and expect there will be resources available to implement the mitigation. The Navy has determined that the mitigation measures within this Mitigation Action Plan are within the Navy's legal authority to implement, and anticipates that resources will be available to ensure mitigation performance. The CEQ also recommends that agencies take steps to ensure that mitigation commitments are actually implemented. The Navy's Environmental Readiness Program Manual (OPNAVINST 5090.1D CH-1) directs action proponents to identify and track mitigation and monitoring requirements committed to in environmental planning decision documents. This Mitigation Action Plan details specific mitigation measures, parties responsible for implementing each measure, schedule for implementation, funding, performance criteria, monitoring and tracking mechanisms, and enforcement measures.

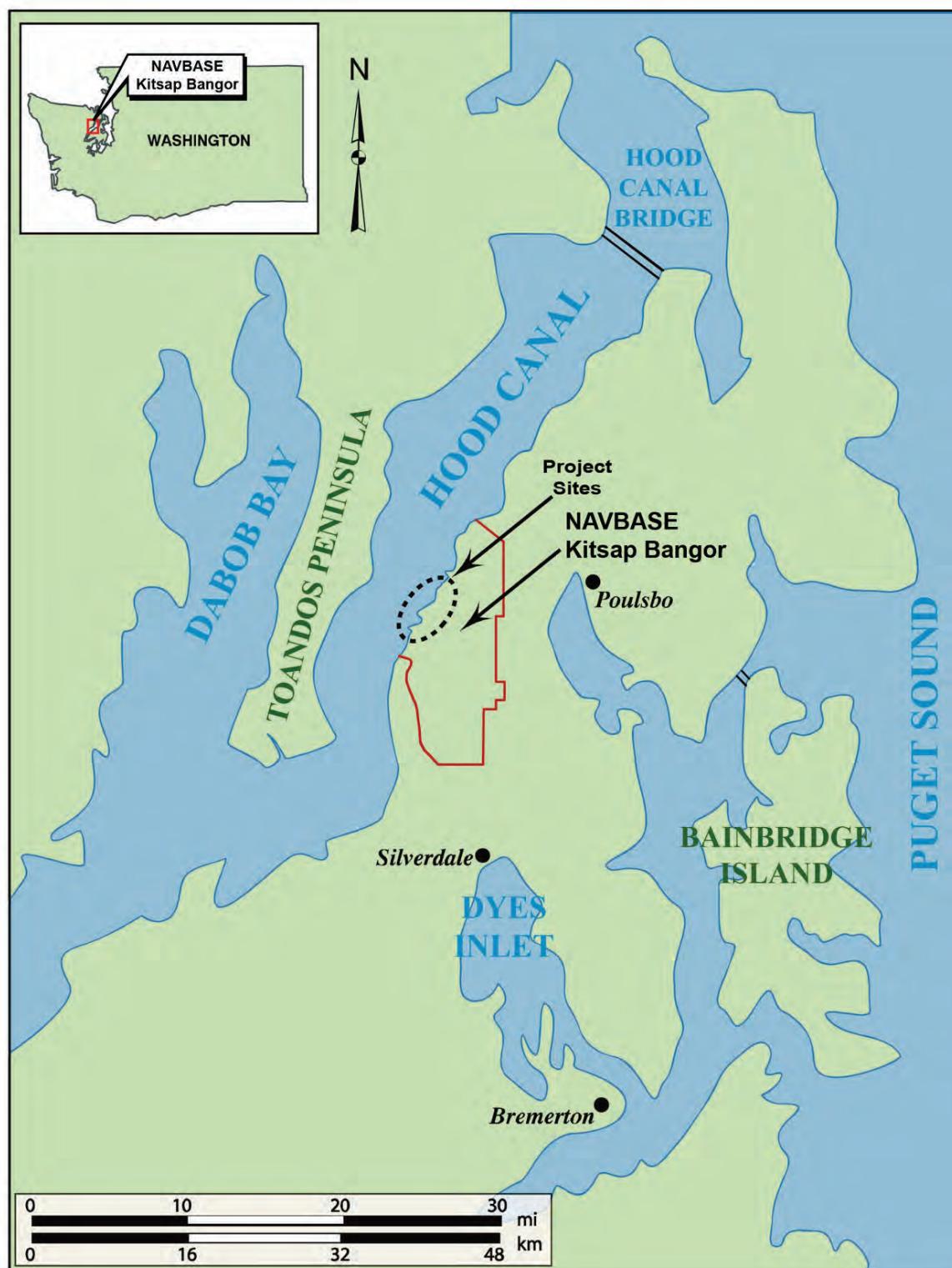


Figure 1. Vicinity Map

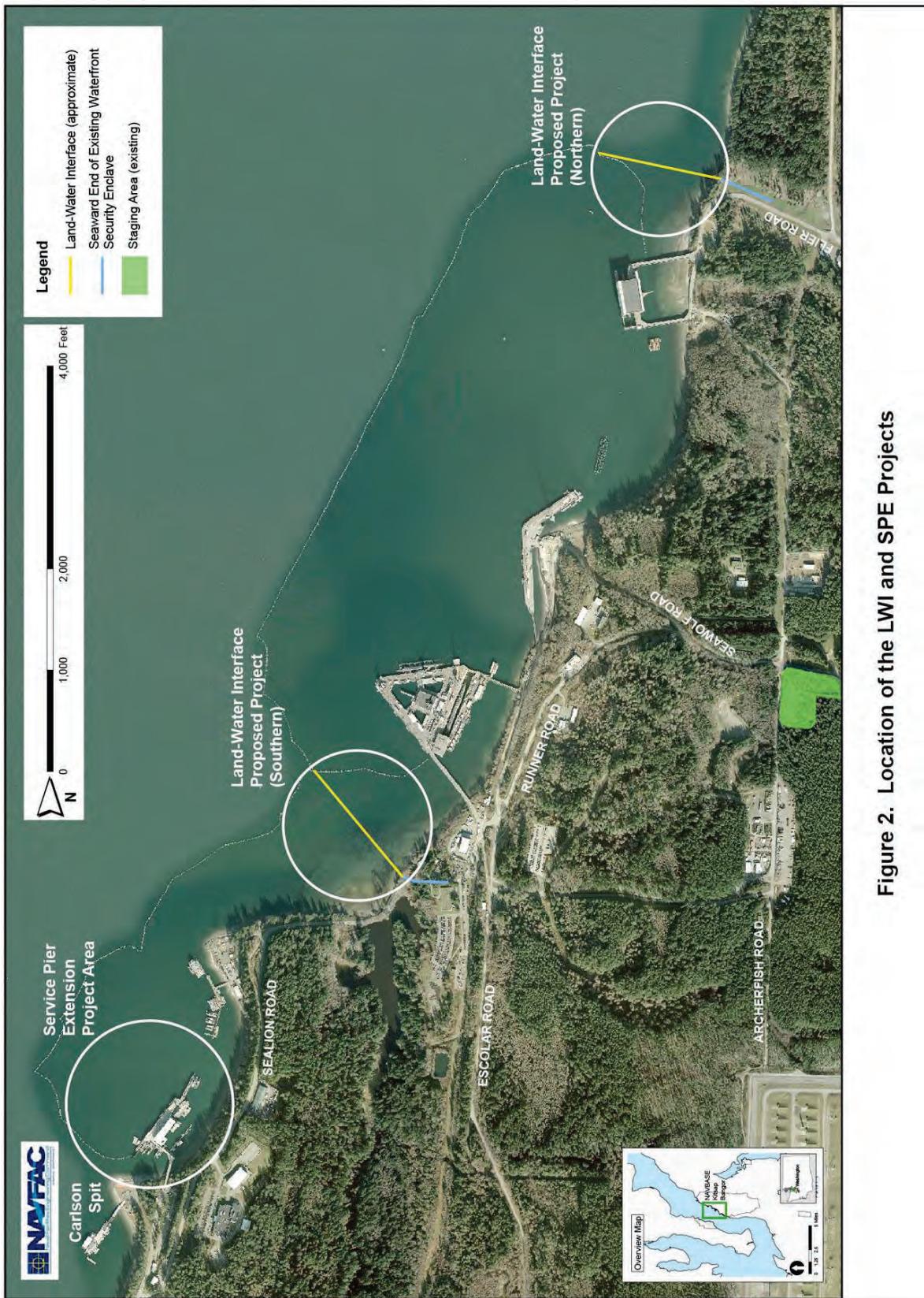


Figure 2. Location of the LWI and SPE Projects

The CEQ encourages agencies to include public involvement components in their mitigation monitoring programs and provide public access to mitigation monitoring information. This Mitigation Action Plan requires the Navy to submit monitoring reports to federal resource agencies at the conclusion of each year of in-water construction. The Navy will make these reports available to the public on a Navy website.

Aspects of the LWI and SPE projects have the potential to cause environmental impacts. Several measures, including current practices (CPs), best management practices (BMPs), and mitigation measures (MMs), will be applied to the project to avoid, reduce, and mitigate the effects from this action. These measures are in conjunction with project compliance to all applicable regulations or permit conditions. CPs are physical, structural, or managerial practices that decrease the potential for impacts, particularly related to water quality. BMPs are required to ensure compliance with the U.S. Environmental Protection Agency (USEPA) general permit for stormwater discharges from construction sites. They can be used singly or in combination as appropriate in a particular situation. Mitigation measures are used most frequently to reduce or minimize impacts that are unavoidable. These measures are described in Sections 2 through 5 of this Mitigation Action Plan and summarized in Table 1. Section 6 of this Mitigation Action Plan describes the Navy's proposed Compensatory Mitigation action, which would offset unavoidable adverse impacts on other aquatic resources. Mitigation measures will be documented in the Records of Decision (ROD) for each of the two proposed actions.

1.1. PROPOSED ACTION

The Navy proposes two projects on the Bangor waterfront to: (1) comply with Department of Defense (DoD) directives to protect Navy OHIO Class Ballistic Missile submarines (TRIDENT submarines) from increased and evolving threats and to prevent the seizure, damage, or destruction of military assets; and (2) eliminate deployment constraints and improve maintenance of the SEAWOLF fleet. The LWI Proposed Action includes constructing two LWI structures and modifying the existing floating Port Security Barrier (PSB) system for improved protection of TRIDENT submarines. Construction of the LWI structures would enclose the Navy WRA on NAVBASE Kitsap Bangor by constructing security barriers in the intertidal zone at the Bangor waterfront.

The SPE Proposed Action would relocate the SEAWOLF Class submarines SSN-21 (SEAWOLF) and SSN-22 (CONNECTICUT) from NAVBASE Kitsap Bremerton to join SSN-23 (JIMMY CARTER) on NAVBASE Kitsap Bangor. The relocation would result in the consolidation of SEAWOLF Class submarines at NAVBASE Kitsap Bangor. The existing Service Pier would be extended and land-based associated support facilities would be constructed, including a maintenance support facility, utility upgrades that include an emergency power generator, and a parking lot. Shore-based facilities constructed on the pier would include a Pier Services and Compressor Building and a pier crane.

Detailed descriptions of the marine and land components of the two proposed actions, including the purpose and need, are provided in Chapters 1 and 2 of the Environmental Impact Statement (EIS).

Table 1. Summary of Mitigation Measures for the LWI and SPE Projects

Mitigation Measures	Timing and Methods	Responsible Party(ies)	Performance and Enforcement
1. Protection of Marine Water Quality and Seafloor During Construction			
Impact: Contaminant loading via stormwater runoff from construction sites. BMP 1: Implement stormwater pollution prevention plan (SWPPP).	Implement SWPPP prior to the start of construction phase. Install and maintain all structural BMPs throughout construction phase in accordance with SWPPP and permit.	The Navy will be responsible for obtaining USEPA Construction General Permit and complying with permit conditions. The contractor will be responsible for implementing and maintaining BMPs specified in the SWPPP.	Conduct monitoring and inspections as required by SWPPP to document compliance with permit conditions.
Impact: Accidental spill of oil, fuels, or other related materials. CP 1a: Implement oil and hazardous spill contingency plan, and deploy containment boom during in-water construction as required.	Use existing NAVBASE Kitsap Bangor fuel spill prevention and response plans (the <i>Commander Navy Region Northwest Oil and Hazardous Substance Integrated Contingency Plan</i> and the <i>NAVBASE Kitsap Bangor Spill Prevention, Control, and Countermeasure Plan</i> [COMNAVREGNWINST 5090.1, Integrated Contingency Plan, Annex G]); Navy is responsible for providing plans, training, and spill response materials.	The contractor will be responsible for notifying the Navy of any fuel spills. The Navy will be responsible for implementing the plan, notifying appropriate agencies, and providing oversight for incident response.	Containment and cleanup of spilled materials as soon as possible; investigate cause of spill; identify and implement appropriate corrective actions to prevent recurrence.
Impact: Incidental release of construction debris and related contaminants. CP 1b: Develop and implement debris management procedures, deploy containment boom during in-water construction, and handle removed treated piles as required.	Develop and implement procedures prior to start of in-water construction activities.	The contractor will be responsible for developing and implementing the procedures. The Navy will be responsible for reviewing and approving the procedures and for monitoring implementation.	The contractor will be responsible for deploying and maintaining booms, as required, throughout construction period and ensuring that all debris and other materials are collected and properly disposed of. Following completion of in-water construction activities, the contractor will conduct an underwater survey to collect and remove any remaining construction materials.

Table 1. Summary of Mitigation Measures for LWI and SPE Projects (continued)

Mitigation Measures	Timing and Methods	Responsible Party(ies)	Performance and Enforcement
Impact: Prop wash from work vessels could resuspend bottom sediments. CP 1c: Instruct vessel operators to avoid excess engine thrust in water depths shallower than 30 feet (9 meters) to the extent possible.	Conduct briefings with vessel operators prior to start of in-water construction activities.	The contractor will be responsible for briefing vessel operators. The Navy will be responsible for monitoring in-water activities and developing and implementing corrective actions as needed.	Visual inspection to ensure prop wash from vessel operations is not causing sediment resuspension and surface turbidity plumes.
Impact: Grounding of work vessels could disturb bottom sediments. CP 1d: Instruct vessel operators to avoid bottoming out (running aground).	Conduct briefings with vessel operators prior to start of in-water construction activities.	The contractor will be responsible for briefing vessel operators. The Navy will be responsible for monitoring in-water activities and developing and implementing corrective actions as needed.	Visual inspection to ensure work vessels are not grounding during low tides.
Impact: Anchoring work vessels could disturb bottom sediments. CP 1e: Develop a mooring and anchoring plan and implement measures to avoid dragging anchors and lines in special status areas.	Develop plan and obtain plan approval prior to start of in-water construction activities. Conduct briefings with vessel operators prior to start of in-water construction activities.	The contractor will be responsible for developing the plan and briefing vessel operators. The Navy will be responsible for reviewing and approving the plan, monitoring in-water activities, and developing and implementing corrective actions as needed.	Visual inspection to ensure anchor and line recovery operations are causing minimal sediment disturbance.
2. In-Water Work Windows			
Impact: In-water construction activities could interfere with seasonal migrations or life stages of sensitive marine species. MM 2: In-water construction will observe an in-water juvenile salmonid work window.	In-water work will be restricted to periods coinciding with the specified work window (July 16 through January 15). An exception is that, for the LWI project, in-water work other than pile driving and abutment work below MHHW could occur outside the in-water work window.	The construction contractor will be responsible for ensuring that in-water work does not occur outside of the work window except as noted. The Navy will be responsible for monitoring in-water work activities.	The Navy will take necessary corrective actions if the construction contractor does not comply with work window restrictions.

Table 1. Summary of Mitigation Measures for LWI and SPE Projects (continued)

Mitigation Measures	Timing and Methods	Responsible Party(ies)	Performance and Enforcement
3. Protection of Upland Water Quality During Construction			
Impact: Increased potential for erosion and sedimentation from stormwater runoff. BMP 3: Implement SWPPP.	Implement SWPPP prior to the start of construction phase. Install and maintain all structural BMPs throughout construction phase in accordance with SWPPP and permit.	The Navy will be responsible for obtaining permit and complying with permit conditions. The contractor will be responsible for implementing and maintaining BMPs specified in the SWPPP.	Conduct monitoring and inspections as required by SWPPP to document compliance with permit conditions.
4. Protection of Water Quality During Operations			
Impact: Contaminant loadings from stormwater runoff discharges from the project sites. BMP 4: Implement SWPPP.	Implement SWPPP prior to the start of operation phase. Install and maintain all structural BMPs throughout operation phase in accordance with SWPPP, Erosion and Sedimentation Control Plan, and permit.	The Navy will be responsible for obtaining National Pollutant Discharge Elimination System (NPDES) permit and implementing and maintaining BMPs specified in the SWPPP and Erosion and Sedimentation Control Plan.	Conduct monitoring and inspections as required by SWPPP to document compliance with permit conditions.
Impact: Contaminant loadings from stormwater runoff discharges from the project sites. CP 4a: Implement low impact development (LID) integrated management practices (IMP).	Implement practices prior to the start of operation phase. Install and maintain all structural IMPs throughout operation phase.	The Navy will be responsible for implementing and maintaining IMPs.	Conduct monitoring and inspections to document effectiveness of practices and compliance with permit conditions.
Impact: Accidental spills from vessels or wharf operations. CP 4b: Implement oil and hazardous spill contingency plan.	Use existing NAVBASE Kitsap Bangor fuel spill prevention and response plans (the <i>Commander Navy Region Northwest Oil and Hazardous Substance Integrated Contingency Plan</i> and the <i>NAVBASE Kitsap Bangor Spill Prevention, Control, and Countermeasure Plan</i> [COMNAVREGNWINST 5090.1, Integrated Contingency Plan, Annex G]); Navy will be responsible for providing plans, training, and spill response materials.	Navy will be responsible for implementing the plan, notifying appropriate agencies, and providing oversight for incident response.	Containment and cleanup of spilled materials as soon as possible; investigate cause of spill; identify and implement appropriate corrective actions to prevent recurrence.

Table 1. Summary of Mitigation Measures for LWI and SPE Projects (continued)

Mitigation Measures	Timing and Methods	Responsible Party(ies)	Performance and Enforcement
5. Noise Attenuation During Construction			
Impact: Noise from in-water construction activities could impact marine species. MM 5a: Use vibratory driver for pile driving, with the exception of use of impact hammer to drive concrete piles, to proof piles and in cases where vibratory methods are not able to drive the pile to tip elevation. MM 5b: Deploy air bubble curtain or other noise attenuating device during impact hammer operations for steel piles. MM 5c: Use soft start for impact pile driving operations. MM 5d: Observe timing restrictions on pile driving.	These measures will apply to all in-water pile driving operations throughout the construction phase for both projects.	The contractor will be responsible for implementing these measures. The Navy will be responsible for monitoring construction activities.	Performance objective is minimizing potential for noise-related impacts on sensitive species. The Navy will be responsible for monitoring and enforcing these measures (see #6). Documentation will be submitted by the Navy to National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service (USFWS).
6. Monitoring to Minimize Noise Impacts			
Impact: Noise from construction activities could impact sensitive species. MM 6: Conduct marine mammal and marbled murrelet monitoring during pile driving operations. Suspend pile driving operations when sensitive species are present in shutdown zone.	Marine mammal and marbled murrelet monitoring will be conducted daily prior to and during pile driving operations to determine whether individuals of these species are present in the shutdown and behavioral disturbance zones and to ensure that pile driving is suspended as needed.	The Navy will be responsible for ensuring trained monitors conduct real-time monitoring for sensitive species. The Navy will be responsible for notifying the contractor when sensitive species are present in the shutdown and behavioral disturbance zones. The contractor will be responsible for suspending pile driving operations until notified by the trained monitors that the zones are clear of sensitive species.	The Navy will be responsible for monitoring and enforcing this measure. Documentation will be submitted by the Navy to NMFS and USFWS.

Table 1. Summary of Mitigation Measures for LWI and SPE Projects (continued)

Mitigation Measures	Timing and Methods	Responsible Party(ies)	Performance and Enforcement
7-12. Mitigation Measures for Biological, Cultural, and Other Resources			
Impact: Shading effects and/or physical disturbance of eelgrass. CP 7: Avoid spudding/anchoring in existing eelgrass habitat whenever possible. Vessel operators will be provided with maps of the construction area with eelgrass beds clearly marked.	This measure will be implemented for the duration of in-water construction work.	The construction contractor will be responsible for ensuring that all vessel operators observe this measure. The Navy will also be responsible for monitoring in-water construction activities.	The performance criterion for these requirements is minimizing project-related impacts on eelgrass beds. The Navy will be responsible for monitoring and enforcing these measures.
Impact: Physical disturbance of upland habitat. MM 8a: A revegetation plan will be developed with the objective of restoring native vegetation to the areas temporarily cleared for the construction laydown area and construction of new roads. MM 8b: Any seed mixtures used in the site will include native grass and herbaceous species, which will provide foraging habitat for wildlife.	These measures will be implemented at the completion of the construction phase in the areas temporarily cleared for the construction laydown area and for construction of new roads. Monitoring will continue for 10 years. Depending on the program developed, the mitigation measure(s) may be completed after construction begins.	The Navy will be responsible for developing and implementing the revegetation plan.	The performance criterion is recovery of the native plant and wildlife communities within areas disturbed by construction operations. Recovery will be monitored and enforced by the Navy.
MM 8c: Periodic monitoring for and removal of noxious weeds from all upland areas cleared for project operations or facilities, and immediately adjacent to the cleared area. Particular attention will be paid to the interface between disturbed and existing adjacent second-growth forest stand. Noxious weeds will be removed by hand, mechanical means, or herbicides as appropriate.			

Table 1. Summary of Mitigation Measures for LWI and SPE Projects (continued)

Mitigation Measures	Timing and Methods	Responsible Party(ies)	Performance and Enforcement
MM 8d: Dense weed infestations that require more intensive treatments that result in ground disturbance will be reseeded or planted with native species. A more intensive monitoring and maintenance program (such as once a month) will be implemented until the native plants are sufficiently established to minimize invasion by noxious weeds.			
Impact: Inadvertent discovery of unknown archaeological resources MM 9: In compliance with Section 106 of NHPA, inadvertent discovery of unknown archaeological resources would require work stoppage and consultation with the SHPO and affected tribes.	This measure will be implemented throughout the duration of construction.	The Navy will be responsible for consulting with the SHPO and affected tribes.	The specific performance criteria for this measure will be established as part of the agreement implementing the mitigation measures. The SHPO will be responsible for enforcing this measure.
Impact: Airborne noise levels from pile driving and other construction activities would exceed allowable noise limits for the Occupational Safety and Health Administration (OSHA). Airborne noise would exceed nighttime maximum residential levels imposed by WAC (50 A-weighted decibel [dBA]) at Thorndyke Bay. Underwater noise from pile driving could affect divers. MM 10a: Construction activities will not be conducted during the hours of 10:00 p.m. to 7:00 a.m. Between July 16 and September 23, impact pile driving will occur between 2 hours after sunrise and 2 hours before sunset to protect foraging marbled murrelets during the breeding season. Between September 24 and	These measures will be implemented throughout the duration of construction. The Navy will notify the public about upcoming construction activities and noise at the beginning of each construction season.	The construction contractor will be responsible for ensuring that all vessel operators observe this measure. The Navy will also be responsible for monitoring in-water construction activities. The Navy will be responsible for implementing this measure.	The Navy will be responsible for enforcing these measures.

Table 1. Summary of Mitigation Measures for LWI and SPE Projects (continued)

Mitigation Measures	Timing and Methods	Responsible Party(ies)	Performance and Enforcement
January 15, in-water construction activities will occur during daylight hours (sunrise to sunset). MM 10b: The Navy will notify the public about upcoming construction activities and noise at the beginning of each construction season. The Notice to Mariners (MM 11a) would also serve to notify divers, including tribal divers, of potential underwater noise impacts.			
Impact: Temporary adverse noise impact to recreational areas. MM 10b (described above)	These measures will be implemented throughout the duration of construction.	The Navy will be responsible for implementing these measures.	The Navy will be responsible for enforcing these measures.
Impact: Increased marine vessel traffic. MM 11a: The Navy will develop a local Notice to Mariners to establish uniform procedures to facilitate the safe transit of vessels operating in the project vicinity. MM 11b: Barge trips and associated bridge openings will be scheduled to avoid peak commuting hours.	These measures will be implemented throughout the duration of construction.	The Navy will be responsible for implementing these measures.	The Navy will be responsible for enforcing these measures.
Impact: Disturbance and loss of marine/aquatic habitat, including eelgrass MM 12: Compensatory aquatic mitigation will be implemented to fully mitigate all impacts on waters of the U.S. The Navy will partner with the Hood Canal Coordinating Council (HCCC), an in-lieu-fee (ILF) sponsor, to implement the mitigation action in the Kitsap County/Hood Canal region.	This measure will be implemented as soon as possible, will take several years to implement, and will require a minimum of 5 years of monitoring. Methods are described in Section 6.0.	Under the ILF program, the Navy will provide the funding while the ILF sponsor will be responsible for planning, implementing and managing the mitigation action. Under a permittee-responsible mitigation, the Navy will be responsible for all aspects.	Compensatory mitigation must comply with the Compensatory Mitigation for Losses of Aquatic resources, Final Rule (USACE and USEPA 2008).

1.2. SCHEDULE

Construction of the LWI would occur from May 2016 to May 2018. Construction activities planned for July 2016 through January 2017 may involve pile driving. In-water construction, including pile driving and abutment work below mean higher high water (MHHW), for the proposed projects will occur during an in-water work window of July 16 to January 15 (described under Section 2.2). One exception is that, for the LWI project, in-water work other than pile driving and abutment work below MHHW, such as pier mesh and anchor installation, could occur outside the in-water work window. Once the pile driving and abutment work below MHHW is complete, other in-water construction activities may occur in the water up until January 2018. The design life of the LWI Proposed Action is 50 years.

Construction of the SPE would occur from July 2018 to July 2020. Construction in the water is planned for July through January of each year, beginning in July 2018 and concluding in January 2020. The design life of the SPE Proposed Action is 50 years.

Construction would typically occur 6 days per week. Upland construction would occur between 7:00 a.m. and 10:00 p.m. in accordance with the WAC noise guidelines.

Timing restrictions on pile driving, to protect Endangered Species Act (ESA)-listed marbled murrelet during the breeding season, are described in Section 3.2.4.

1.3. COMPENSATORY AQUATIC MITIGATION

Section 6 of this Mitigation Action Plan describes the Navy's proposed Compensatory Mitigation action, which would offset unavoidable adverse impacts on aquatic resources. Compensatory mitigation is required by the Clean Water Act (CWA) Section 404 and Sections 9 and 10 of the Rivers and Harbors Act of 1899. Compensatory Mitigation must comply with the USACE and USEPA Compensatory Mitigation for Losses of Aquatic Resources, Final Rule (USACE and USEPA 2008).

1.4. MONITORING AND REPORTING PROCEDURES

Mitigation measures will be implemented in accordance with this Mitigation Action Plan. Prior to release of bid specifications, construction plans will be provided to the Navy for review and approval. Operational mitigation measures will be monitored by the Navy and any specified responsible parties designated by the Navy.

This Mitigation Action Plan will be in place through all phases of the project, including design, construction, and operation, and will help ensure that project objectives are achieved. The Navy will be responsible for administering the plan and ensuring that all parties comply with its provisions. The Navy may delegate monitoring activities to staff, consultants, or contractors. All construction contractors will submit an Environmental Protection Plan for Construction Management and approval prior to beginning construction activities. This plan will document how the contractor intends to comply with all measures applicable to the contract including application of BMPs. The Navy also will ensure that monitoring is documented through periodic reports and that deficiencies are promptly corrected. The designated environmental monitor will

track and document compliance with mitigation measures, note any problems that may result, and take appropriate action to rectify problems.

1.5. MITIGATION MONITORING AND REPORTING PROGRAM IMPLEMENTATION

This Mitigation Action Plan was prepared to verify compliance with individual mitigation measures. This plan identifies each mitigation measure by discipline, the entity (organization) responsible for its implementation, the report/permit/certification required for each measure, and an accompanying form used to certify completion. Certain inspections and reports must be prepared by qualified individuals, and these are specified as needed. The timing and method of verification for each measure is also specified.

1.6. ADAPTIVE MANAGEMENT

The proposed actions include adaptive management to minimize environmental impacts. The Navy will evaluate results from other pile-driving operations and research to ensure the most appropriate noise attenuation measures and procedures are applied during project construction, as discussed in Sections 3.2.1, 3.2.2, and 3.2.3 of this Mitigation Action Plan. Mitigation measures will include visual monitoring of marine mammals and marbled murrelets, and shut down of pile driving when these species approach or enter areas where injury may occur.

This page is intentionally blank.

2.0 CURRENT AND BEST MANAGEMENT PRACTICES

2.1. PROTECTION OF MARINE WATER QUALITY AND SEAFLOOR DURING CONSTRUCTION

2.1.1. Potential Impacts

Construction-related impacts on water quality will be limited to temporary (minutes to hours) and localized changes associated with resuspension of bottom sediments from pile installation and barge and tug operations, such as anchoring and propeller wash, as well as accidental losses or spills of construction debris into Hood Canal. These changes will be spatially limited to the construction corridor, including areas potentially impacted by anchor drag and areas immediately adjacent to the corridor (i.e., up to approximately 100 feet [30 meters] from the offshore edge of the construction corridor) that could be impacted by plumes of resuspended bottom sediments, and will not violate applicable state or federal water quality standards. Nevertheless, several CPs and BMPs will be implemented to protect marine water quality and the seafloor during construction of both projects. These measures are intended to prevent or minimize potential impacts associated with the following:

- Contaminant loadings from stormwater discharges containing runoff from the construction site;
- Accidental spills or releases of contaminants from work vessels;
- Accidental or incidental release of construction debris and related contaminants;
- Excessive sediment resuspension from prop wash;
- Seafloor disturbances from grounding of work vessels; and
- Seafloor disturbances from anchor dragging.

2.1.2. Environmental Protection Measures

The following measures will be implemented to address each of the above potential impacts.

2.1.2.1. STORMWATER POLLUTION PREVENTION PLAN (BMP 1)

2.1.2.1.1. DESCRIPTION

During project construction, stormwater discharges will be in accordance with a USEPA Construction General Permit. The Navy will also seek a Water Quality Certification from the Washington Department of Ecology (WDOE), under Section 401 of the CWA, certifying that the proposed actions will not violate state water quality standards. The contractor will submit a Storm Water Notice of Intent (NOI) (for coverage under the general permit for construction activities) and a SWPPP for the project to the Contracting Officer and obtain approval prior to the commencement of work. The SWPPP will be filed, through the Contracting Officer, to the appropriate federal or state agency for approval, a minimum of 14 calendar days prior to the start of construction. The contractor and the Navy will file Notices of Intent for permit coverage and Notices of Termination once construction is complete.

The SWPPP will meet the requirements of the USEPA general permit for stormwater discharges from construction sites, following guidance in WDOE's *Stormwater Management Manual for Western Washington* (WDOE 2012). The SWPPP will specify the BMPs that will be implemented during all phases of construction to limit contaminant discharges to Hood Canal and monitoring requirements to document compliance with permit conditions. In addition, the SWPPP will:

- Identify potential sources of pollution that may be reasonably expected to affect the quality of stormwater discharge from the sites;
- Describe and ensure implementation of practices that will be used to reduce the pollutants in stormwater discharge from the sites;
- Ensure compliance with terms of the USEPA Construction General Permit for stormwater discharge;
- Select applicable BMPs from the USEPA guide to developing SWPPPs for construction sites (USEPA 2007, EPA 833-R-060-04); and
- Select applicable BMPs from the WDOE *Stormwater Management Manual for Western Washington* (WDOE 2012).

The contractor will be required to install, inspect, and maintain BMPs, and to conduct and document SWPPP site inspections. The contractor will ensure construction operations and management are in compliance with the terms and conditions of the general permit for stormwater discharges from construction activities.

The contractor will create and maintain a three-ring binder of documents at the construction onsite office that demonstrate compliance with the Stormwater Construction Activity permit. The binder will include a copy of the permit Registration Statement, SWPPP and SWPPP update amendments, inspection reports, copies of correspondence with the agency that issued the permit, and a copy of the permit Notice of Termination. At the completion of the project, the folder will be provided to the Contracting Officer and will become the property of the Navy. An advance copy of the Registration Statement will be provided to the Contracting Officer immediately after the form is presented to the permitting agency.

2.1.2.1.2. PARTY(IES) RESPONSIBLE FOR IMPLEMENTATION

The contractor will be responsible for preparing and submitting an application for the Construction General Permit. The USEPA will review the application and issue the permit. The contractor will be responsible for implementing all required BMPs, including maintenance of structural BMPs, and performing all monitoring and reporting as required by the permit.

2.1.2.1.3. PLANNED IMPLEMENTATION SCHEDULE

Construction General Permit coverage will be obtained prior to the start of all construction work and maintained for the duration of the construction phase. The SWPPP will be implemented prior to the start of construction. Once construction is complete, the Navy will be responsible for updating the existing industrial SWPPP to reflect changes in the facility and operations associated with the LWI and SPE.

2.1.2.1.4. PLANNED FUNDING

Implementation of the Construction General Permit and SWPPP, including installation and maintenance of BMPs, will be part of the contractor's scope of work, and will be funded under the Navy's construction contract.

2.1.2.1.5. MITIGATION-SPECIFIC PERFORMANCE CRITERIA

The performance criteria will be as specified in the Construction General Permit.

2.1.2.1.6. MONITORING AND TRACKING MECHANISMS

As the co-permittee, the contractor will be responsible for monitoring and reporting per the specifications in the permit.

2.1.2.1.7. ENFORCEMENT MEASURES

The Construction General Permit will be enforced by the USEPA. Non-compliance with the permit could be used as a basis for corrective actions and/or fines.

2.1.2.2. SPILL PREVENTION CONTROL MEASURE (CP 1A)

2.1.2.2.1. DESCRIPTION

The existing facility response plans for the Bangor waterfront provide guidance that will be used in a spill response, such as a response procedures, notification, and communication plan; roles and responsibilities; and response equipment inventories (COMNAVREGNINST 5090.1, Integrated Contingency Plan, Annex G). In the event of an accidental spill, response measures will be implemented immediately to reduce potential impacts on the surrounding environment.

This measure will consist of the following elements:

- Spill kits will be maintained on site and readily available,
- The contractor and crew will be trained in spill prevention and containment techniques,
- Spill prevention will be implemented daily by maintaining awareness in the construction crew and monitoring the activities, and
- Clean and well-maintained equipment and tools will be used.

Additionally, during in-water construction activities, an absorbent oil containment boom will be placed around the construction area, as required by the CWA Section 401 Water Quality Certification for the projects, to contain accidental oil or hazardous materials spills and prevent or minimize impacts on marine mammals or other fish and wildlife species.

2.1.2.2.2. PARTY(IES) RESPONSIBLE FOR IMPLEMENTATION

The Navy will be responsible for providing copies of the spill response plans to the contractors and training the contractor and crew in spill prevention and containment techniques. The Navy also will be responsible for maintaining all equipment and supplies required for a spill response.

The contractor will be responsible for exercising due diligence to prevent, contain, and respond to spills of hazardous material, hazardous substances, hazardous waste, sewage, regulated gas, petroleum, lubrication oil, and other substances regulated by environmental law. In the event of a spill, the contractor will take prompt, effective action to stop, contain, curtail, or otherwise limit the amount, duration, and severity of the spill/release. In the event of any releases of oil and hazardous substances, chemicals, or gases; the contractor will immediately (within 15 minutes) notify the Base or Activity Fire Department, the activity's Command Duty Officer, and the Contracting Officer. The Navy is responsible for verbal and written notifications as required by the federal 40 Code of Federal Regulations (CFR) 355, state, local regulations, and Navy Instructions. Spill response will be in accordance with 40 CFR 300 and applicable state and local regulations.

2.1.2.2.3. PLANNED IMPLEMENTATION SCHEDULE

The existing spill response plans will be implemented for the duration of the construction phase. An oil containment boom will be in place as required by the CWA Section 401 Water Quality Certification for the projects.

2.1.2.2.4. PLANNED FUNDING

If Government assistance is requested or required, the contractor will reimburse the Navy for such assistance. Funding for maintaining spill response activities will be part of the Navy's existing Operations and Maintenance budget.

2.1.2.2.5. MITIGATION-SPECIFIC PERFORMANCE CRITERIA

Performance criteria will be in accordance with the existing plans.

2.1.2.2.6. MONITORING AND TRACKING MECHANISMS

Monitoring and tracking will be in accordance with the existing plans.

2.1.2.2.7. ENFORCEMENT MEASURES

Deficiencies in the spill response, notification, or cleanup will be cause for corrective actions. The contractor will reimburse the government for all costs incurred including sample analysis materials, equipment, and labor if the government must initiate its own spill cleanup procedures, for contractor responsible spills, when (a) the contractor has not begun spill cleanup procedure within one hour of spill discovery/occurrence or (b) if, in the Navy's judgment, the contractor's spill cleanup is not adequately abating a life threatening situation and/or is a threat to any body of water or environmentally sensitive areas.

2.1.2.3. CONSTRUCTION DEBRIS AND PILE REMOVAL CONTROL MEASURES (CP 1B)

2.1.2.3.1. DESCRIPTION

This measure will consist of the following elements:

The contractor will prepare and implement construction debris management procedures as required by the Clean Water Act Section 401 Water Quality Certification for the project. Debris

will be prevented from entering the water during all demolition or new construction work. During in-water construction activities, the contractor will deploy and maintain floating booms no further seaward than the 100-foot (30-meter) designated construction corridor to collect and contain floatable materials. Any accidental release of equipment or materials will be immediately retrieved and removed from the water. Uncured concrete or slurries will not be discharged. The contractor will provide a temporary platform or other suitable means of capturing debris from all demolition operations. Debris which could pollute storm water will be stored, covered and frequently removed from the site. Following completion of in-water construction activities, an underwater survey will be conducted to remove any remaining construction materials that may have been missed previously. Removed debris will be disposed of at an approved upland disposal site.

Old piles will be removed by cutting below the mudline and backfilling the resulting hole with clean sediment. During removal of old piles, removed creosote-treated wood piles and associated sediments (if any) will be contained on a barge or, if a barge is not utilized, stored in a containment area near the construction site. All creosote-treated material and associated sediments will be disposed of in a landfill that meets the liner and leachate standards of the Washington Administrative Code (WAC).

2.1.2.3.2. PARTY(IES) RESPONSIBLE FOR IMPLEMENTATION

The Navy will require the construction contractor to retrieve and clean up any debris spilled into Hood Canal. The contractor will be responsible for preparing and implementing the procedures. The Navy will be responsible for reviewing and approving the procedures and for monitoring their implementation.

2.1.2.3.3. PLANNED IMPLEMENTATION SCHEDULE

The construction debris management procedures and controls will be in place and approved by the Navy Contracting Officer prior to the start of any in-water construction work. These procedures will be implemented throughout the in-water construction period including post-construction removal of any remaining debris.

2.1.2.3.4. PLANNED FUNDING

The construction debris management procedures will be part of the contractor's scope of work, and will be funded under the Navy's construction contract.

2.1.2.3.5. MITIGATION-SPECIFIC PERFORMANCE CRITERIA

The performance criteria will be no loss of floatable debris outside of the flotation booms and no debris will be left on the seafloor during and after construction is complete. Following completion of in-water construction activities, an underwater survey will be conducted to remove any remaining construction materials that may have been missed during previous cleanups.

2.1.2.3.6. MONITORING AND TRACKING MECHANISMS

The Navy will be responsible for monitoring compliance with the construction debris management procedures. The Navy will monitor for compliance using a combination of visual inspections and written correspondence/documentation from the contractor.

2.1.2.3.7. ENFORCEMENT MEASURES

Non-compliance with the procedures could be used as a basis for corrective actions or non-payment of contractor invoices.

2.1.2.4. PROP WASH CONTROL MEASURE (CP 1C)**2.1.2.4.1. DESCRIPTION**

To minimize disturbances of the seafloor from prop wash, vessel traffic will be excluded from shallow areas outside of the 100-foot (30-meter) construction zone, which will be marked using temporary buoys or other visual guides. Additionally, shallow draft, low horsepower tugboats will be used in the nearshore area and for extended operations in areas shallower than about 40 feet (12 meters) below mean lower low water (MLLW).

2.1.2.4.2. PARTY(IES) RESPONSIBLE FOR IMPLEMENTATION

The contractor will be responsible for implementing this measure.

2.1.2.4.3. PLANNED IMPLEMENTATION SCHEDULE

This measure will be implemented throughout the construction phase.

2.1.2.4.4. PLANNED FUNDING

No additional funding will be required for this measure.

2.1.2.4.5. MITIGATION-SPECIFIC PERFORMANCE CRITERIA

The performance criterion for this measure is complete avoidance of excessive prop wash, causing unnecessary resuspension of bottom sediments as manifested by the presence of surface turbidity plumes within the project sites.

2.1.2.4.6. MONITORING AND TRACKING MECHANISMS

The Navy will be responsible for monitoring in-water construction activities. The construction contractor will be responsible for monitoring and tracking compliance with this measure.

2.1.2.4.7. ENFORCEMENT MEASURES

Non-compliance with this measure could be used as a basis for corrective actions or non-payment of contractor invoices.

2.1.2.5. WORK VESSEL GROUNDING CONTROL MEASURE (CP 1D)**2.1.2.5.1. DESCRIPTION**

To minimize seafloor disturbances, construction of the LWI and SPE will be conducted from barges in deep-water areas and/or from land to the extent possible. Construction barges will avoid grounding in eelgrass beds during low tides. Spudding/anchoring in existing eelgrass habitat will be avoided wherever possible. Vessel operators will be provided with maps of the project site with eelgrass beds clearly marked. For the LWI Alternative 2 south pier,

construction impacts on the intertidal zone and other shallow habitats would be minimized by conducting pile driving, deck placement, and other actions from a temporary trestle built adjacent to the permanent pier out to a depth of approximately 1 foot below MLLW. The abutments and observation posts will be built from land.

2.1.2.5.2. PARTY(IES) RESPONSIBLE FOR IMPLEMENTATION

The construction contractor will be responsible for ensuring that all work vessel operations comply with this measure.

2.1.2.5.3. PLANNED IMPLEMENTATION SCHEDULE

This measure will be implemented throughout the construction phase.

2.1.2.5.4. PLANNED FUNDING

No additional funding will be required for this measure.

2.1.2.5.5. MITIGATION-SPECIFIC PERFORMANCE CRITERIA

The performance criterion for this measure is complete avoidance of vessel grounding at the project site.

2.1.2.5.6. MONITORING AND TRACKING MECHANISMS

The Navy will be responsible for monitoring in-water construction activities. The construction contractor will be responsible for monitoring and tracking compliance with this measure.

2.1.2.5.7. ENFORCEMENT MEASURES

Non-compliance with this measure could be used as a basis for corrective actions or non-payment of contractor invoices.

2.1.2.6. MOORING AND ANCHORING PLAN (CP 1E)

2.1.2.6.1. DESCRIPTION

To minimize the potential for seafloor disturbances, the contractor will submit a mooring and anchoring plan for approval by the Contracting Officer. The plan will identify measures to be taken to avoid or minimize significant impacts on bottom habitats in areas identified on the construction drawings from line or anchor drag. Measures will include:

1. Placement of anchors outside of special status areas, to the extent feasible;
2. Placement and retrieval of any anchors required within special status areas using a secondary work boat and/or vertical lift system to avoid/minimize dragging; and
3. Use of a buoy(s) (surface or subsurface) along the lower portion of mooring lines required within special status areas to avoid/minimize dragging.

2.1.2.6.2. PARTY(IES) RESPONSIBLE FOR IMPLEMENTATION

The construction contractor will be responsible for preparing the plan and ensuring that all work vessel operations comply with the approved plan.

2.1.2.6.3. PLANNED IMPLEMENTATION SCHEDULE

This measure will be implemented throughout the construction phases of both projects.

2.1.2.6.4. PLANNED FUNDING

No additional funding will be required for this measure.

2.1.2.6.5. MITIGATION-SPECIFIC PERFORMANCE CRITERIA

The performance criterion for this measure is complete avoidance of dragging anchors or lines through sensitive bottom habitat at the project sites.

2.1.2.6.6. MONITORING AND TRACKING MECHANISMS

The Navy will be responsible for monitoring in-water construction activities. The construction contractor will be responsible for monitoring and tracking compliance with this measure.

2.1.2.6.7. ENFORCEMENT MEASURES

Non-compliance with this measure could be used as a basis for corrective actions or non-payment of contractor invoices.

2.2. IN-WATER WORK WINDOW (MM 2)**2.2.1. Potential Impacts**

In-water construction work could interfere with migrating salmonids and/or sensitive life stages of protected species during certain portions of the year.

2.2.2. Mitigation Measures (MM 2)

Construction activities with the greatest potential to harm fish, notably pile driving, will observe an in-water work window of July 16 to January 15, when ESA-listed salmonids are least likely to be present. The Puget Sound Marine Area 13 (northern Hood Canal) in-water juvenile salmonid work window is currently July 16 to February 15, as outlined in WAC-220-110-271 and USACE (2012). The Navy is proposing the shorter window to reflect best available science considerations for minimizing in-water project impacts on migrating juvenile salmonids, primarily Hood Canal summer-run chum. All in-water work will occur only during the work window to minimize the number of ESA-listed salmonids exposed to underwater noise and other disturbance. The exception is that, for the LWI project, in-water work other than pile driving and abutment work below MHHW could occur outside the in-water work window.

2.2.3. Party(ies) Responsible for Implementation

The construction contractor will be responsible for ensuring that no in-water construction work occurs outside of the work window, except non-pile driving in-water work for the LWI project and that operations comply with this measure.

2.2.4. Planned Implementation Schedule

This measure will be implemented throughout the construction phase.

2.2.5. Planned Funding

No additional funding will be required for this measure.

2.2.6. Mitigation-Specific Performance Criteria

The performance criterion for this measure is complete avoidance of in-water construction work during non-work windows, as modified.

2.2.7. Monitoring and Tracking Mechanisms

The Navy will be responsible for monitoring in-water construction activities. The construction contractor will be responsible for monitoring and tracking compliance with this measure.

2.2.8. Enforcement Measures

Non-compliance with this measure could be used as a basis for corrective actions or non-payment of contractor invoices. ESA requirements will be enforced by USFWS and NMFS. Marine Mammal Protection Act (MMPA) requirements will be enforced by NMFS. Section 10 and 404 permit conditions will be enforced by USACE.

2.3. PROTECTION OF UPLAND WATER QUALITY DURING CONSTRUCTION (BMP 3)

2.3.1. Potential Impacts

During construction, there will be increased potential for erosion and sedimentation from stormwater runoff, which could entrain sediment that would cause temporary localized degradation of some water quality parameters.

2.3.2. Mitigation Measures

2.3.2.1. IMPLEMENT SWPPP (BMP 3)

Construction activities will be in accordance with the USEPA Construction General Permit. For compliance with the Energy Independence and Security Act of 2007, the Navy will maintain site hydrology to the maximum extent feasible. Design of upland features (e.g., laydown area) will consider the USEPA guidance for compliance with the Energy Independence and Security Act (EISA) (USEPA 2009) as well as other relevant technical information regarding methods to improve stormwater retention and quality.

A number of measures will be implemented to protect water quality, including installation of a temporary runoff capture and discharge system, and installation of temporary siltation barriers below the excavation/construction zone, to control stormwater runoff into Hood Canal. Proper installation, routine maintenance, and periodic monitoring of BMPs, in accordance with the SWPPP, will ensure that the measures are effective and minimize the potential for impacts on marine water quality.

During shoreside mobilization of equipment, existing native vegetation will not be disturbed outside of the work area. BMPs for clearing, grading, and maintenance will be employed as needed to control erosion and sedimentation, including the possible use of benched surfaces, downdrain channels, diversion berms and ditches, erosion control blankets or turf reinforcement mats, plastic coverings, silt fences and check dams, and straw bales. Gravel pads will be installed at construction area access points to prevent tracking of soil onto paved roads. Water-spraying on soil will be used to control dust generation during earthmoving and hauling.

2.3.3. Party(ies) Responsible for Implementation

The contractor will be responsible for installing, maintaining, and monitoring BMPs, as specified in the SWPPP, and for ensuring compliance with the conditions of the Construction General Permit.

2.3.4. Planned Implementation Schedule

These measures will be completed prior to the start of construction and maintained for the duration of the construction phases of both projects.

2.3.5. Planned Funding

Implementation of the Construction General Permit and SWPPP, including installation and maintenance of BMPs, will be part of the contractor's scope of work, and would be funded under the Navy's construction contract.

2.3.6. Mitigation-Specific Performance Criteria

The performance criteria will be as specified in the Construction General Permit.

2.3.7. Monitoring and Tracking Mechanisms

As the co-permittee, the contractor will be responsible for monitoring and reporting per the specifications in the permit.

2.3.8. Enforcement Measures

The Construction General Permit will be enforced by USEPA. Non-compliance with the permit could be used as a basis for corrective actions and/or fines.

2.4. PROTECTION OF WATER QUALITY DURING OPERATIONS

2.4.1. Potential Impacts

Operation of the LWI and SPE would not require dredging or placement of fill or direct discharges of waste to the marine environment, other than stormwater discharges. Potential operational impacts on water quality would be limited to the following:

- Contaminant loadings from stormwater runoff discharges from the project sites, and
- Accidental spills or releases of contaminants from work vessels.

Stormwater discharges during operations will be in accordance with the Navy's Multi-Sector General Permit (MSGP) for Stormwater Discharges associated with Industrial Activity and the NAVBASE Kitsap Bangor SWPPP. Stormwater runoff from the LWI structures would not require treatment and could discharge directly into Hood Canal because the structure surfaces are expected to consist largely of inert materials and would not represent a source of substantial pollutant loadings to Hood Canal. Drainage water from the SPE project site would be collected in a trench drain on the pier, treated using an in-line canister system designed to meet the basic treatment requirements of the WDOE Stormwater Management Manual for Western Washington, and then discharged to Hood Canal in accordance with an NPDES permit. Thus, operations would not intentionally release materials that would have a potential to impact marine water quality, and WDOE stormwater standards would be maintained.

Operation of the LWI would not increase the risk of accidental spills because, other than minor, small boat operations, project operations would not require use of explosives, solvents, or other contaminants. The existing NAVBASE Kitsap Bangor fuel spill prevention and response plans (the *Commander Navy Region Northwest Oil and Hazardous Substance Integrated Contingency Plan* and the *NAVBASE Kitsap Bangor Spill Prevention, Control, and Countermeasure Plan* [COMNAVREGNWINST 5090.1, Integrated Contingency Plan, Annex G]) would minimize the risk of fuel spills from small boat operations. In the event of an accidental spill, emergency cleanup measures would be implemented immediately in accordance with state and federal regulations. Operation of the SPE would not increase the risk of accidental spills of fuel, explosives, cleaning solvents, and other contaminants that, if spilled, would impact water quality in Hood Canal. This is because BMPs and CPs (including the existing NAVBASE Kitsap Bangor spill prevention and response plans), would minimize the risk from fuel spills. In the event of an accidental spill, emergency cleanup measures would be implemented immediately in accordance with state and federal regulations. The cleanup would minimize impacts on the surrounding environment. Thus, the potential for impacts on water quality from LWI and SPE operations is expected to be minimal.

2.4.2. Mitigation Measures

2.4.2.1. INTEGRATED SWPPP (BMP 4)

Stormwater runoff discharges during operations will be regulated by the MSGP and the NAVBASE Kitsap Bangor industrial activity SWPPP. Drainage water from the SPE project site would be collected in a trench drain on the pier, treated using an in-line canister system designed to meet the basic treatment requirements of the WDOE Stormwater Management Manual for Western Washington, and then discharged to Hood Canal in accordance with the MSGP permit.

Thus, operations will not intentionally release materials that would have a potential to impact marine water quality and WDOE water quality standards would be maintained.

2.4.2.2. LOW IMPACT DEVELOPMENT (CP 4A)

To comply with Section 438 of the EISA, the Navy will implement LID strategies in accordance with UFC 3-210-10N (*Low Impact Development*; DoD November 2010). LID is a stormwater management strategy designed to maintain site hydrology and mitigate the adverse impacts of stormwater runoff and non-point source pollution. LID provides decentralized hydrologic source control for stormwater using IMPs, which are distributed small-scale controls that closely maintain or replicate hydrological behavior of the natural system for a defined design storm event. These strategies are intended to complement the federal, state, and local regulations pertaining to stormwater management. LID employs principles such as preserving and recreating natural landscape features, minimizing effective imperviousness to create functional and appealing site drainage that treats stormwater as a resource rather than a waste product. Many practices have been used to adhere to these principles such as bioretention facilities, rain gardens, vegetated rooftops, rain barrels, and permeable pavements. By implementing LID principles and practices, water can be managed in a way that reduces the impact of built areas and promotes the natural movement of water within an ecosystem or watershed.

2.4.2.3. OIL AND HAZARDOUS SPILL CONTINGENCY (CP 4B)

Prevention, containment, and cleanup of spills associated with project operations are addressed by the existing facility response plans for the Bangor waterfront (COMNAVREGNINST 5090.1, Integrated Contingency Plan, Annex G). The plan provides guidance that would be used in a spill response, such as a response procedures, notification, and communication plan; roles and responsibilities; and response equipment inventories. In the event of an accidental spill, response measures would be implemented immediately to reduce potential impacts on the surrounding environment. Containment practices would be consistent with the existing NAVBASE Kitsap Bangor waterfront structures, including the use of in-water containment booms and facility response plans, and would minimize the risk of spills during operations.

2.4.3. Party(ies) Responsible for Implementation

The Navy will be responsible for implementing the SWPPP and complying with the permit conditions. The Navy in conjunction with the project designer will be responsible for ensuring that the projects are designed with features needed to meet the EISA requirements.

2.4.4. Planned Implementation Schedule

The industrial discharge permit and spill response plan are already in place. The SWPPP will be modified to reflect the new waterfront facilities and any related changes in collection, treatment, and discharge of stormwater.

2.4.5. Planned Funding

No additional funding will be required.

2.4.6. Mitigation-Specific Performance Criteria

The performance criterion for stormwater discharges is compliance with the industrial discharge permit conditions. The performance criteria for spill response are included in the plan, and these include training, maintaining equipment and supplies of spill cleanup materials, and effectiveness as determined by regular spill response exercises.

2.4.7. Monitoring and Tracking Mechanisms

Monitoring and reporting requirements for the stormwater discharges are specified in the industrial discharge permit.

2.4.8. Enforcement Measures

The terms and conditions of the industrial discharge permit are enforced by USEPA, and non-compliance with the permit could result in regulatory actions.

This page is intentionally blank.

3.0 NOISE ATTENUATION DURING CONSTRUCTION

3.1. POTENTIAL IMPACTS

Pile driving noise would likely result in behavioral disturbance of ESA-listed fish (salmonids and rockfish), ESA-listed marbled murrelet, birds protected under the Migratory Bird Treaty Act (MBTA), and marine mammals protected under the MMPA. There is also a potential for noise-related injury to these species. This section addresses noise attenuation measures to minimize the potential for noise-related impacts on marine species during construction.

Marine mammal and marbled murrelet monitoring, which would be conducted during pile driving, is discussed in Section 4. The in-water work window restrictions, described in Section 2.2, would also reduce the potential for pile driving noise-related impacts on migrating salmonids.

3.2. MITIGATION MEASURES

The following noise attenuation measures will be implemented to minimize noise levels due to pile driving and other construction operations.

3.2.1. Use of Vibratory Driver in Lieu of Impact Hammer (MM 5a)

3.2.1.1. DESCRIPTION

The vibratory pile driver will be the primary method for driving steel piles; an impact hammer will be used primarily to drive concrete piles and to proof vibratory driven piles, but also to drive steel piles which cannot be driven to the required depth using a vibratory pile driver because of geotechnical conditions. Under the preferred Alternatives, the number of impact hammer strikes will not exceed 2,000 per day. No more than one impact hammer will be used concurrently for each project (LWI and SPE). Under current schedules, construction of the two projects would not overlap in time; therefore pile driving for the two projects would not occur at the same time.

3.2.1.2. PARTY(IES) RESPONSIBLE FOR IMPLEMENTATION

The construction contractor will be responsible for ensuring that use of impact hammers does not exceed the parameters described above.

3.2.1.3. PLANNED IMPLEMENTATION SCHEDULE

This measure will be implemented throughout the construction phases of both projects.

3.2.1.4. PLANNED FUNDING

No additional funding will be required for this measure.

3.2.1.5. MITIGATION-SPECIFIC PERFORMANCE CRITERIA

The performance criterion for this measure is to reduce the use of impact hammers to the extent possible and, at a minimum, comply with the use restrictions described above.

3.2.1.6. MONITORING AND TRACKING MECHANISMS

The Navy will be responsible for monitoring in-water construction activities. The construction contractor will be responsible for monitoring and tracking compliance with this measure.

3.2.1.7. ENFORCEMENT MEASURES

Non-compliance with this measure could be used as a basis for corrective actions or non-payment of contractor invoices.

3.2.2. Deploy Air Bubble Curtains or Other Noise Attenuating Device(s) for Impact Hammer Operations (MM 5b)**3.2.2.1. DESCRIPTION**

The contractor will deploy an air bubble curtain, or other noise attenuating device, around impact hammer operations for steel piles during in-water construction. The purpose of the bubble curtain noise attenuator is to reduce underwater pile driving noise levels. The bubble curtain will also reduce the radius of the area in which injurious or disturbing noise levels could occur, thus reducing the area in which fish, marine mammals, and birds would potentially be exposed to injury or disturbance.

3.2.2.2. PARTY(IES) RESPONSIBLE FOR IMPLEMENTATION

The construction contractor will be responsible for ensuring that bubble curtains are deployed and operational around all impact hammer operations.

3.2.2.3. PLANNED IMPLEMENTATION SCHEDULE

This measure will be implemented during all impact hammer operations for steel piles for both projects.

3.2.2.4. PLANNED FUNDING

Funding for this measure will be included in the construction contract.

3.2.2.5. MITIGATION-SPECIFIC PERFORMANCE CRITERIA

The performance criterion for this measure is testing of proper bubble curtain deployment. Pile driving will not be allowed to start until a bubble curtain is shown to be deployed properly.

Construction contractor will be responsible for not exceeding performance measures.

3.2.2.6. MONITORING AND TRACKING MECHANISMS

Monitoring in-water noise levels is discussed in Section 4 of this Mitigation Action Plan.

3.2.2.7. ENFORCEMENT MEASURES

ESA and MMPA requirements will be enforced by the Navy. Navy staff will ensure that the bubble curtain has been deployed properly. Assessments will be done by a monitoring contractor. Non-compliance with this measure could be used as a basis for corrective actions or non-payment of contractor invoices.

3.2.3. Soft Start for Pile Driver Operations (MM 5c)

3.2.3.1. DESCRIPTION

The objective of a soft start is to provide a warning and/or give animals in close proximity to pile driving a chance to leave the area prior to an impact driver operating at full capacity, thereby exposing fewer animals to loud underwater and airborne sounds.

- A soft-start procedure will be used at the beginning of each day's in-water pile driving or any time pile driving has ceased for more than 30 minutes.
- For impact pile driving, the following soft-start procedures will be conducted as follows:
 - If a bubble curtain is used for steel impact pile driving, the contractor will start the bubble curtain prior to the initiation of impact pile driving in order to flush fish from the injury zone near the pile.
 - The contractor will provide an initial set of strikes from the impact hammer at reduced energy, followed by a 30-second waiting period, then two subsequent sets. (The reduced energy of an individual hammer strike cannot be quantified because strikes vary by individual drivers. Also, the number of strikes will vary at reduced energy because raising the hammer at less than full power and then releasing it results in the hammer "bouncing" as it strikes the pile, resulting in multiple "strikes.")

For vibratory pile driving, the contractor will initiate noise from vibratory hammers for 15 seconds at reduced energy followed by a 30-second waiting period. The procedure will be repeated two additional times. If marine mammal monitoring data indicate that there is no change in behavior of pinnipeds during vibratory pile driving or soft-start procedures and the NMFS concurs, then the soft-start procedure would no longer be required. Due to mechanical limitations, soft starts for vibratory driving will be conducted only with drivers equipped with variable moment features. Typically, this feature is not available on larger, high-power drivers. The Navy will use the driver model most appropriate for the geologic conditions at the project location, and will perform soft starts if the hammer is equipped to conduct them safely.

3.2.3.2. PARTY(IES) RESPONSIBLE FOR IMPLEMENTATION

The construction contractor will be responsible for ensuring that soft-start procedures are employed for all pile driver operations.

3.2.3.3. PLANNED IMPLEMENTATION SCHEDULE

This measure will be implemented throughout the construction phases of both projects.

3.2.3.4. PLANNED FUNDING

No additional funding will be required for this measure.

3.2.3.5. MITIGATION-SPECIFIC PERFORMANCE CRITERIA

The performance criterion for this measure is consistent use of this method for pile driver operations.

3.2.3.6. MONITORING AND TRACKING MECHANISMS

The Navy will be responsible for monitoring in-water construction activities. The construction contractor will be responsible for monitoring and tracking compliance with this measure.

3.2.3.7. ENFORCEMENT MEASURES

ESA and MMPA requirements will be enforced by USFWS and NMFS. Navy staff will ensure that marine mammal and marbled murrelet monitoring is conducted in accordance with agency-approved monitoring plans. Assessments will be done by monitoring Navy reports/records. Non-compliance with this measure could be used as a basis for corrective actions or non-payment of contractor invoices.

3.2.4. Timing Restrictions (MM 5d)**3.2.4.1. DESCRIPTION**

Construction activities will not be conducted between the hours of 10:00 p.m. and 7:00 a.m. Pile driving will be limited to daylight hours due to the requirement for visual monitoring of ESA-listed marbled murrelet presence in the construction area (described in Section 4.2.1). Impact pile driving during the first part of the in-water work window (July 16 to September 23) will only occur between 2 hours after sunrise and 2 hours before sunset to protect foraging marbled murrelets during the breeding season. Vibratory pile driving and other construction activities occurring in the water between July 16 and September 23 will occur during daylight hours (sunrise to sunset). Between September 24 and January 15, in-water construction activities will occur during daylight hours (sunrise to sunset).

3.2.4.2. PARTY(IES) RESPONSIBLE FOR IMPLEMENTATION

The construction contractor will be responsible for ensuring that pile driving work occurs during daylight hours only.

3.2.4.3. PLANNED IMPLEMENTATION SCHEDULE

This measure will be implemented throughout the construction phases of both projects.

3.2.4.4. PLANNED FUNDING

No additional funding will be required for this measure.

3.2.4.5. MITIGATION-SPECIFIC PERFORMANCE CRITERIA

The performance criterion for this measure is minimizing all construction-related noises during the night.

3.2.4.6. MONITORING AND TRACKING MECHANISMS

The Navy will be responsible for monitoring in-water construction activities. The construction contractor will be responsible for monitoring and tracking compliance with this measure.

3.2.4.7. ENFORCEMENT MEASURES

ESA and MMPA requirements will be enforced by USFWS and NMFS. Navy staff will ensure that marine mammal and marbled murrelet monitoring is conducted in accordance with agency-approved monitoring plans. Assessments will be done by monitoring Navy reports/records. Non-compliance with this measure could be used as a basis for corrective actions or non-payment of contractor invoices.

This page is intentionally blank.

4.0 MONITORING TO MINIMIZE NOISE IMPACTS

4.1. POTENTIAL IMPACTS

Pile driving noise could disturb ESA-listed fish (salmonids and rockfish), ESA-listed marbled murrelet, MBTA-protected birds, and MMPA-protected marine mammals. There will also be a potential for noise-related injury to these sensitive species. Marine mammal and marbled murrelet monitoring will be conducted during pile driving operations to reduce the potential for injury to ESA and non-ESA listed species. The movements of survey boats engaged in marbled murrelet monitoring during pile driving operations will tend to discourage seabirds from foraging or resting inside the injury zones while noise levels are elevated, as seabirds generally withdraw from moving boats. Thus, the marbled murrelet monitoring protocol will also protect MBTA-protected seabird species as well as the marbled murrelet from exposure to construction noise.

4.2. MITIGATION MEASURES

The monitoring program described below will be implemented during the construction phases of the LWI and SPE projects to reduce impacts on protected species. The monitoring program will include visual monitoring of marine mammals, visual monitoring of marbled murrelets, data collection, and reporting. The monitoring results will be used to assess the need to suspend pile driving operations when sensitive species are present in the work areas. These components are described below. The Navy is in consultation with the regulatory agencies about specific monitoring plans for regulated species. The monitoring plans discussed in this section may be modified as a result of these ongoing consultations.

4.2.1. Monitoring Plans

The Navy will develop protocol monitoring plans for marine mammal occurrence and marbled murrelet occurrence in coordination with NMFS and the USFWS. A draft marine mammal monitoring plan will be developed and submitted to the NMFS and will be approved prior to the start of construction. Similarly, a marbled murrelet monitoring plan consistent with the USFWS Marbled Murrelet Monitoring Protocol (USFWS 2012) will be developed and submitted to USFWS and will be finalized prior to construction. The basic element of the marine mammal monitoring plan is to designate a shutdown zone for pile driving that will be defined in consultation with NMFS to include all areas where underwater sound pressure levels (SPLs) have the potential to exceed physiological injury-related noise levels for marine mammals (Level A take as defined by the MMPA), based on sound attenuation modeling. The injury zones for marine mammals were determined by sound attenuation modeling based on in situ acoustic monitoring results from other pile driving projects (EHW-2 and Test Pile Project) at NAVBASE Kitsap Bangor, and results for similar pile sizes that were reported in the literature (Appendix D of the EIS). Modeled or calculated injury zones may be different from the shutdown zones. The marbled murrelet monitoring plan will use a shutdown zone for impact pile driving defined as all areas where underwater SPLs have the potential to exceed auditory injury-related noise levels for marbled murrelets, based on sound attenuation modeling. Conditions governing project shutdown for marbled murrelets could be modified subject to an adaptive management strategy. SPL criteria for various species groups are described in Section 4.2.1.2.

The individuals that implement the monitoring protocols will assess their effectiveness using an adaptive management approach. Monitoring biologists will use their best professional judgment throughout implementation and will seek improvements to these methods when deemed appropriate. Any modifications to the protocols will be coordinated between the Navy, USFWS, and NMFS. There will be multiple dedicated observers for the marine mammal and marbled murrelet survey efforts. Marbled murrelet observers will be certified by USFWS to perform the Marbled Murrelet Monitoring Protocol (USFWS 2012).

4.2.1.1. MARINE MAMMAL AND MARBLED MURRELET VISUAL MONITORING (MM 6)

4.2.1.1.1. SHUTDOWN AND BEHAVIORAL DISTURBANCE ZONES (IMPACT AND VIBRATORY PILE DRIVING/REMOVAL) FOR MARINE MAMMALS

- During impact and vibratory pile driving/removal, the shutdown zone will include all areas where the underwater SPLs are anticipated to equal the Level A (injury) harassment criteria for marine mammals (180 dB isopleths for cetaceans; 190 dB isopleths for pinnipeds). The shutdown zone distances will be specified in consultation with NMFS.
- All shutdown zones will initially be based on the distances from the source that were predicted for each threshold level.
- During impact pile driving, the behavioral disturbance zone will include all areas within the PSB where the underwater or airborne SPLs are anticipated to equal or exceed the Level B (disturbance) harassment criteria for marine mammals during impact pile driving (160 dB isopleth). The modeled distance to the 160 dB isopleth for impulsive sound caused by driving 36-inch steel pile is 1,775 feet (541 meters). Marine mammal observers cannot easily see animals on the other side of the PSB and it is not feasible for boats to move through the PSB structures during monitoring due to the intensive security checks required to enter the WRA. Therefore, visual monitoring to the furthest extent of the calculated disturbance zone may be largely obstructed by the PSB. Marine mammal monitors will monitor the area from the driven pile to the PSB at a minimum and will also attempt to record any additional observations of marine mammals beyond the fence.
- During vibratory pile driving, the Level B (disturbance) harassment criterion (120 dB isopleth) predicts an affected area up to 19.3 square miles (50.1 square kilometers) for 36-inch steel piles. The size of this area would make effective monitoring impractical. As a result, a behavioral disturbance zone equivalent to the size of the predicted 160 dB isopleth for impact pile driving, as described above, will be monitored for pinnipeds and cetaceans during all vibratory pile driving/removal activities. Marine mammal observers cannot easily see animals on the other side of the PSB and it is not feasible for boats to move through the PSB structures during monitoring due to the intensive security checks required to enter the WRA. Therefore, visual monitoring to the furthest extent of the calculated disturbance zone may be largely obstructed by the PSB. Marine mammal monitors will monitor the area from the driven pile to the PSB at a minimum and will also attempt to record any additional observations of marine mammals beyond the fence.
- The shutdown and behavioral disturbance zones will be monitored throughout the time required to drive a pile. If a marine mammal enters the behavioral disturbance zone, an exposure will be recorded and behaviors documented. However, the pile segment will be completed without cessation, unless the animal approaches or enters the shutdown zone, at which point all pile driving activities will immediately be halted.

- Under certain construction circumstances, where initiating the shutdown and clearance procedures (which could include a delay of 15 minutes or more) will result in an imminent concern for human safety, the shutdown provision may be waived at the discretion of the construction foreman. The marine mammal monitoring plan will define the situations or criteria in which such a scenario may occur.

4.2.1.1.2. SHUTDOWN ZONE (IN-WATER CONSTRUCTION ACTIVITIES NOT INVOLVING A PILE DRIVING HAMMER) FOR MARINE MAMMALS

- During in-water construction activities not involving a pile driver, but having the potential to affect marine mammals, in order to prevent injury to these species from their physical interaction with construction equipment, a shutdown zone of 33 feet (10 meters) will be monitored to ensure that marine mammals are not present in this zone.
- These activities could include, but are not limited to: (1) movement of the barge to the pile location, (2) positioning of the pile on the substrate via a crane (i.e., “stabbing” the pile), (3) removal of the pile from the water column/substrate via a crane (i.e., “deadpull”), or (4) placement of sound attenuation devices around the piles.

4.2.1.1.3. SHUTDOWN ZONE (IMPACT PILE DRIVING) FOR MARBLED MURRELETS

- Shutdown zones for marbled murrelets include areas where underwater SPLs resulting from impact pile driving are anticipated to equal or exceed auditory injury. There will be a shutdown zone including areas where airborne SPLs resulting from impact pile driving are anticipated to equal or exceed the auditory masking zone. The auditory injury criterion is the 202 dB cumulative sound exposure level (SEL) isopleth for impact pile driving, depending on the number of pile strikes, as determined by sound attenuation modeling. The distance may be adjusted based on the number of pile strikes. The shutdown distances will be specified in consultation with the U.S. Fish and Wildlife Service (USFWS).
- The shutdown zones will be monitored throughout the time required to drive a pile with an impact hammer. If a marbled murrelet is observed in the monitored area, impact pile driving will be stopped until the marbled murrelet leaves the area under its own volition, but pile driving does not need to be stopped for longer than 1 hour per marbled murrelet encounter. Impact pile driving does not need to be curtailed for more than 2 hours total time per day, regardless of the number of marbled murrelets encountered.
- The Navy will document the duration and frequency of shutdowns of impact pile driving due to the presence of marbled murrelets. Should shutdowns occur at a frequency that is significantly affecting the project’s schedule for completion, the Navy may convene an adaptive management group consisting of representatives of the Navy and USFWS to address the issue. The adaptive management group will identify and agree to criteria and timelines for implementation of an adaptive strategy. Any changes or refinements of shutdown zones that are approved by USFWS will be incorporated into the marbled murrelet monitoring plan.

4.2.1.1.4. VISUAL MARINE MAMMAL MONITORING (MM 6)

A Marine Mammal Monitoring Plan will be finalized prior to commencement of pile driving activities. Based on NMFS requirements, the plan will include, at a minimum, the following procedures for impact pile driving.

QUALIFICATIONS

Monitoring will be conducted by qualified, trained marine mammal observers (MMOs). An observer is a biologist with prior training and experience in conducting at-sea marine mammal monitoring or surveys, and who has the ability to identify marine mammal species and describe relevant behaviors that may occur in proximity to in-water construction activities. NMFS requires that the observers have no other construction-related tasks while conducting monitoring. A trained observer will be placed at the best vantage point(s) practicable (e.g., from a small boat, the pile driving barge, on shore, or any other suitable location) to monitor for marine mammals and implement shutdown/delay procedures when applicable by calling for the shutdown to the hammer operator.

METHODS OF MONITORING

The Navy will monitor the vibratory and impact driver shutdown and behavioral disturbance zones before, during, and after pile driving.

- a. MMOs will be located at the best vantage point(s) in order to properly see the entire shutdown zone. This may require the use of a small boat to monitor certain areas while also monitoring from one or more land-based vantage points.
- b. During all observation periods, observers will use binoculars and the naked eye to search continuously for marine mammals.
- c. If the shutdown zones are obscured by fog, sea state, or poor lighting conditions, pile driving will not be initiated until all zones are visible.
- d. The shutdown and behavioral disturbance zones around the pile will be monitored for the presence of marine mammals before, during, and after any pile driving activity.
- e. Marine Mammal Observation Record forms (Attachment A-1) will be used to document observations.

PRE-ACTIVITY MONITORING:

The shutdown zones will be monitored for 15 minutes prior to initiating the soft start for impact pile driving. Soft start will be implemented at the beginning of each pile driving day and after breaks of more than 30 minutes (for impact pile driving only). If marine mammals are present within the shutdown zone prior to pile driving or during the soft start for impact pile driving, the start of pile driving will be delayed until the animals leave the shutdown zone. Pile driving will be initiated only after the MMO has determined, through sighting or by waiting approximately 15 minutes, that the animal(s) has moved outside the shutdown zone.

DURING ACTIVITY MONITORING:

The shutdown zones will be monitored throughout the time required to drive/remove a pile or complete other in-water construction activities. If a marine mammal is observed outside of this zone, an exposure will be recorded and behaviors documented, to the extent practicable. However, that pile segment or other in-water construction activity will be completed without cessation, unless the animal approaches/enters the shutdown zone, at which point all pile driving or other in-water construction activities will be halted and delayed until either the animal has

voluntarily left and been visually confirmed beyond the shutdown zone or 15 minutes have passed without re-detection of the animal. Pile driving can only resume once the animal has left the shutdown zone of its own volition or has not been re-sighted for a period of 15 minutes. However, the shutdown provision may be waived in situations where shutdown would create an imminent concern for human safety.

POST-ACTIVITY MONITORING:

Monitoring of the shutdown and behavioral disturbance zones will continue for 30 minutes following the completion of pile driving. A post-monitoring period is not required for other in-water construction.

4.2.1.1.5. VISUAL MARBLED MURRELET MONITORING (MM 6)

The Navy will conduct marbled murrelet monitoring in compliance with USFWS Protocol for Marbled Murrelet Monitoring during Impact Pile Driving (USFWS 2012). This protocol applies only to impact pile driving. Monitoring will be conducted for marbled murrelets swimming in the water within the underwater auditory injury zone before, during, and after impact pile driving activities. Monitoring of the masking zone will occur before and during impact pile driving. The monitoring distances will be specified in consultation with USFWS. Monitoring will take place from 30 minutes prior to initiation through completion of impact pile driving activities.

QUALIFICATIONS

All observers will be experienced biologists certified through USFWS training to perform the Marbled Murrelet Monitoring Protocol (USFWS 2012).

METHODS OF MONITORING

The Navy will monitor the impact pile driving auditory injury zone before, during, and after pile driving. Based on USFWS protocols, the visual marbled murrelet monitoring will include the following procedures for impact hammer pile driving:

PRE-ACTIVITY MONITORING

The following survey methodology will be implemented prior to commencing impact pile driving activity:

- Transect lines will be established using Global Positioning System (GPS).
- Transect lines will be no more than 164 feet (50 meters) apart. The Navy is working with USFWS and NMFS to define sea states that would preclude the ability to monitor for marine mammals and marbled murrelets effectively and result in pile driving shutdown. As defined by the Beaufort Sea State (BSS) (Attachment B), if the sea state is greater than BSS 2, monitoring cannot be conducted effectively and pile driving activities will cease at BSS 3 or greater. The sea state conditions that would result in stopping pile driving activities may be further defined by wave height or wind conditions, depending on the outcome of ongoing discussions.

- A survey boat will monitor all marbled murrelets within the underwater injury zone radius from pile driving operations. These areas to be monitored will be specified in consultation with USFWS.
- Monitoring will commence at least 30 minutes before the initiation of impact pile driving (but not before daylight) and will continue until pile driving is completed each day (but not after nightfall). Monitoring will not start until 2 hours after sunrise and will cease 2 hours before sunset during the period from July 16 to September 23. Between September 24 and January 15, impact pile driving can occur during daylight hours.
- Impact pile driving will not commence until observers complete two full sweeps of the entire survey area and have determined that no marbled murrelets are within the underwater injury and non-injurious temporary threshold shift (TTS) zones.
- If marbled murrelets are not present within these monitored zones, the observers will communicate with the Lead Biologist, who will radio the Pile Driving Engineer Lead that impact pile driving can commence.
- If marbled murrelets are within these monitored zones, the survey will continue and pile driving will not commence until the murrelets have left the monitored zones. When a murrelet is detected within the monitored zones, it will be continuously observed until it leaves the monitored zones. If observers lose sight of the murrelet, searches for the murrelet will continue for at least 5 minutes. If the murrelet is still not found, then at least two full sweeps of the monitored zones will be conducted prior to resumption of impact pile driving.
- Boat speed will be from 5 to 10 knots per hour.
- Each boat will have a minimum of two observers using binoculars (not including the boat operator).
- In case of fog or reduced visibility, the observers must be able to see a minimum of 164 feet (50 meters) or pile driving will not commence.
- All bird observations will be recorded on the Seabird Monitoring Data Collection Form (Attachment A-2).

DURING-ACTIVITY MONITORING

The underwater auditory injury zones will be monitored throughout impact pile driving. The following monitoring protocol will be implemented:

- The survey protocol identified above will continue and be repeated during pile driving with the following additional conditions.
- If marbled murrelets are seen within the monitored zones during impact pile driving, the observers will communicate with the Lead Biologist, who will communicate to the Pile Driving Engineer Lead. This action will require an immediate shutdown of pile driving. The survey will continue and pile driving will not resume until the murrelets have left the monitored zones. If observers lose sight of the murrelet, searches for the murrelet will continue for at least 5 minutes. If the murrelet still is not found, then at least two full sweeps of the monitored zones will be conducted prior to resumption of impact pile driving.

VISUAL POST-PILE DRIVING OBSERVATIONAL SURVEY

These surveys will observe and record unusual or abnormal behavior of marbled murrelets. During these surveys, dead, injured, or sick seabirds may be discovered. In addition to surveys before and during pile driving, searches for seabird carcasses will be conducted following pile driving activities. Survey results will be noted in the Seabird Monitoring Data Collection Form (Attachment A-2).

Any dead diving seabird found within the survey area will be collected, placed in plastic bags, and kept cool (but not frozen). Carcasses will be submitted to USFWS (Washington Fish and Wildlife Office in Lacey) for necropsy using the Chain of Custody Record Form in Attachment C.

4.2.1.1.6. DATA COLLECTION FOR MARBLED MURRELETS AND MARINE MAMMALS

Each marbled murrelet observer will record information on each survey day using the USFWS-approved Seabird Monitoring Data Collection Form (Attachment A-2) and reference the completed Seabird Monitoring Site/Transects Identification Form (Attachment A-3) (USFWS 2012). The following information will be collected on the data collection form.

- a. Date and time that pile driving begins or ends;
- b. Construction activities occurring during each observation period;
- c. Weather parameters (e.g. wind, humidity, temperature);
- d. Tide state and water currents: the Beaufort Wind Scale (Attachment B) will be used to determine sea state;
- e. Visibility;
- f. Species, numbers, and if possible, sex and age class of marbled murrelets;
- g. Marbled murrelet behavior patterns observed, including bearing and direction of travel, and if possible, the correlation to SPLs;
- h. Distance from pile driving activities to marbled murrelets and distance from the marbled murrelet to the observation point;
- i. Locations of all marbled murrelet observations; and
- j. Other human activity in the area.

MMOs will use NMFS-approved sighting forms. At a minimum, the following information will be collected on the sighting forms:

- a. Date and time that pile driving begins or ends;
- b. Construction activities occurring during each observation period;
- c. Weather conditions (e.g., percent cover, visibility);
- d. Water conditions (e.g., sea state, tidal state [incoming, outgoing, slack, low, and high]);
- e. Species, numbers, and if possible sex and age class of observed marine mammals;

- f. Marine mammal behavior patterns observed, including bearing and direction of travel, and if possible, the correlation to SPLs;
- g. Distance from pile driving activities to marine mammals and distance from the observed species to the observation point;
- h. Locations of all marine mammal observations; and
- i. Other human activity in the area.

4.2.1.1.7. EQUIPMENT

The following equipment will be required to conduct marbled murrelet and marine mammal monitoring:

- a. Portable radio(s) to communicate with the Pile Driving Engineer Lead and with Port Ops and Security;
- b. Hearing protection for biologists;
- c. Cellular phones (one per boat) with contact information (other survey boats, Pile Driving Engineer Lead, USFWS point of contact);
- d. Three green flags (for boat, barges, or land-based observers) as back-up for radio communication;
- e. Three red flags (for boat, barges, or land-based observers) as back-up for radio communication;
- f. Nautical charts;
- g. Tide and current tables for Hood Canal;
- h. Steel-cased thermometer or an equivalent electronic instrument with underwater temperature probe;
- i. Chronometers;
- j. Binoculars with built-in rangefinder – quality 8 or 10 power (6);
- k. Monitoring protocols and equipment list in sealed clear plastic cover;
- l. Notebook with pre-standardized monitoring Seabird Monitoring Data Collection Form on non-bleeding paper;
- m. Seabird identification guides;
- n. Large zip-lock bags for samples;
- o. Clipboard; and
- p. Pen / Pencil.

The detailed marine mammal and marbled murrelet monitoring plans are in development. Most of the identified equipment cited in this section would also apply to both monitoring efforts; other equipment would be added based on agency discussions.

4.2.1.2. REPORTING

Draft annual reports on marine mammal and marbled murrelet monitoring will be submitted to NMFS and USFWS, respectively, within 60 days of the end of each in-water work period. Content and data requirements for the reports will be developed in consultation with NMFS and USFWS. The reports will include marine mammal and marbled murrelet observations prior to activity, during-activity, and post-activity during pile driving days. Final annual reports will be submitted to NMFS and USFWS within 30 days following receipt of comments on the draft reports from NMFS and USFWS. The Navy will make final reports available to the public by posting final reports on a Navy website. At a minimum, the reports will include:

- General data (all reports):
 - Date and time of activity;
 - Water conditions (e.g., sea state, tidal state); and
 - Weather conditions (e.g., percent cover, visibility).
- Description of the pile driving activity being conducted (size and type);
- Pre-, during-, and post-activity observational survey-specific data (Marine Mammal and Marbled Murrelet reports):
 - Dates and time survey is initiated and terminated;
 - Description of any observable marine birds, marine mammals, or fish behavior in the immediate area during monitoring;
 - Actions performed to minimize impacts on marine mammals and marbled murrelets;
 - Description of any “take” (as described in NMFS or USFWS Biological Opinions);
 - Copies of field data sheets or logs;
 - Birds salvaged for necropsy (if applicable);
 - Use Chain of Custody Record Form (Attachment C) for dead birds/threatened and endangered species (as required); and
 - Necropsy results, based on information provided by the Agencies (as required).

4.2.1.3. INTERAGENCY NOTIFICATION

Observers will immediately notify USFWS upon locating a dead, injured or sick marbled murrelet specimen. Notification must be made to the USFWS Law Enforcement Office at (425) 883-8122 or the Services’ Western Washington Fish and Wildlife Office at (360) 753-9440, and include the date, time, precise location of the injured bird or carcass, and any other pertinent information. In addition, one of the following Washington Fish and Wildlife Office staff will be notified:

Nancy Brennan-Dubbs – phone: (360) 753-5835
Emily Teachout – phone: (360) 753-9583
Deanna Lynch – phone: (360) 753-9545

Care should be taken in handling sick or injured birds in order to preserve biological specimens in the best possible state for later analysis of cause of death, if that occurs. In conjunction with the care of the sick or injured specimens or preservation of biological materials from a dead animal, the finder has the responsibility to ensure that evidence associated with the specimen is not unnecessarily disturbed.

4.3. PARTY(IES) RESPONSIBLE FOR IMPLEMENTATION

The Navy will be responsible for conducting marine mammal and marbled murrelet monitoring during pile driving operations. The observers will be responsible for communicating with the construction contractor and providing information on when impact hammer operations can be initiated without disturbing sensitive species. The construction contractor will be responsible for ensuring that impact hammer operations comply with this measure.

4.4. PLANNED IMPLEMENTATION SCHEDULE

The monitoring plans will be approved by NMFS and USFWS prior to the start of in-water construction activities. Monitoring activities will be performed in accordance with the approved plan throughout the construction phase.

4.5. PLANNED FUNDING

Monitoring activities will be funded by the Navy.

4.6. MITIGATION-SPECIFIC PERFORMANCE CRITERIA

The performance objective will be to minimize the take of sensitive marine species, and this objective will be achieved by implementing the approved monitoring plan and limiting pile driving operations to periods when sensitive species are not present in the shutdown and behavioral disturbance zones.

4.7. MONITORING AND TRACKING MECHANISMS

Monitoring and reporting will be in accordance with the approved monitoring plan.

4.8. ENFORCEMENT MEASURES

Compliance with this measure will be enforced by NMFS and USFWS.

5.0 MITIGATION MEASURES FOR BIOLOGICAL, CULTURAL, AND OTHER RESOURCES

The LWI and SPE projects are expected to affect portions of the nearshore benthic and littoral habitats on NAVBASE Kitsap Bangor, particularly as related to potential effects on submerged macroalgae (eelgrass) beds and habitat and migration pathways for salmonids. Short-term and long-term impacts on eelgrass and eelgrass beds, and to the benthic community, could affect ESA-listed fish species directly, and all species indirectly through effects on prey resources. Both projects could affect migration of juvenile salmonids along the NAVBASE Kitsap Bangor shoreline. Otherwise, operation of the LWI and SPE are not expected to adversely affect ESA-listed species. Compensatory mitigation projects for impacts on marine habitats and prey populations will be undertaken on the shoreline that will restore some of the habitat and prey base functions of the project area (Section 6).

5.1. MITIGATION MEASURES FOR OTHER BIOLOGICAL IMPACTS

This section addresses mitigation measures for biological impacts other than underwater noise impacts (Sections 3.0 and 4.0), and impacts requiring compensatory mitigation (Section 6.0).

5.1.1. Potential Impacts

The LWI and SPE projects are expected to cause unavoidable impacts on marine resources, as well as impacts on terrestrial vegetation and wildlife communities. BMPs and mitigation measures to reduce these impacts are discussed below. The Navy's proposed aquatic mitigation plan to compensate for the unavoidable impacts of the proposed actions on aquatic habitats and species is described in Section 6.0.

In-water construction would result in water quality impacts and disruption of the seafloor that would affect marine organisms. Installation of piles and anchors would displace marine habitat, while installation of marine structures (piers) would result in shading of marine habitat. Construction of on-land facilities would result in clearing of vegetation.

5.1.2. Mitigation Measures

Potential impacts on fish and benthic communities will be minimized by several of the environmental protection measures described previously for protecting water quality and the seafloor. These include:

- Deployment of oil containment booms during in-water construction to minimize potential impacts from an accidental oil spill, as required by the CWA Section 401 Water Quality Certifications for the projects (**CP 1a**);
- Retrieval of lost debris from the seafloor during and following in-water construction to prevent disturbance of benthic habitat (**CP 1b**);
- Prohibiting work vessels to ground in shallow waters, and excluding construction equipment and activities outside of the 100-foot (30-meter) construction corridor (**CP 1d**); and
- Restricting in-water work to specified work windows to minimize in-water project impacts on potentially occurring ESA-listed fish species that would otherwise be exposed to construction

activities, including underwater noise produced during pile driving (**MM 2**). The exception is that in-water work other than pile driving and LWI abutment construction below MHHW could occur outside the in-water work window.

An additional measure to prevent or minimize impacts on eelgrass beds is:

- Spudding/anchoring in existing eelgrass habitat will be avoided during in-water construction (**CP 7**).

Efforts to restore the temporarily cleared upland areas to a natural vegetation community and comply with EO 13112 would include the following mitigation measures:

- A revegetation plan will be developed to establish a coniferous forest overstory and native shrub understory on the site, with the objective of restoring wildlife benefits to the site (**MM 8a**).
- Any seed mixtures used in the site will include native grass and herbaceous species, which would provide foraging habitat for wildlife (**MM 8b**).
- The Navy will conduct periodic monitoring for and removal of noxious weeds from within and immediately adjacent to the cleared area. Particular attention will be paid to the interface between disturbed and existing adjacent second-growth forest stand. Noxious weeds, such as Scotch broom and Himalayan blackberry, will be removed by hand, mechanical means, or herbicides per the NAVBASE Kitsap Bangor Pest Management Plan (Navy 2004) (**MM 8c**).
- Dense weed infestations that require more intensive treatments that result in ground disturbance will be reseeded or planted with native species. A more intensive monitoring and maintenance program (such as once a month) will be implemented until the native plants are sufficiently established to minimize invasion by noxious weeds (**MM 8d**).

5.1.3. Party(ies) Responsible for Implementation

The Navy will be responsible for restoring and monitoring the terrestrial vegetation in areas affected by construction activities.

5.1.4. Planned Implementation Schedule

The revegetation plan will be prepared and approved prior to the completion of the project's construction phase. Once construction activities have stopped, the plan will be implemented. Monitoring will occur for 10 years following revegetation activities.

5.1.5. Planned Funding

These revegetation activities will be funded by the Navy as part of the overall project.

5.1.6. Mitigation-Specific Performance Criteria

The performance criterion for the revegetation measure is development of native plant and wildlife communities in upland areas affected by the project construction activities. An adaptive management plan will be included.

5.1.7. Monitoring and Tracking Mechanisms

The condition of the revegetated areas will be monitored by the Navy for 10 years following revegetation activities.

5.1.8. Enforcement Measures

This measure will be enforced by the Navy.

5.2. MITIGATION MEASURES FOR CULTURAL RESOURCES IMPACTS

5.2.1. Potential Impacts

The Navy will comply with Section 106 of the National Historic Preservation Act (NHPA)¹. The Navy has completed Section 106 consultation with the Washington State Historic Preservation Officer (SHPO), with a finding of no adverse effect on historic properties. Tribal consultation is ongoing. If, in the course of the construction, operation or maintenance of any component of the LWI or SPE, there is an unanticipated discovery of cultural resources, work will be stopped and the Navy cultural resources manager will be contacted to determine subsequent steps in compliance with Section 106 of NHPA and other relevant cultural resources legislation. The Navy will continue to comply with DoD policy and other laws and regulations, including the American Indian Religious Freedom Act of 1978 and Native American Graves Protection and Repatriation Act of 1990, if the need arises.

5.2.2. Mitigation Measures (MM 9)

In compliance with Section 106 of NHPA, inadvertent discovery of unknown archaeological resources would require consultation with the SHPO and affected tribes.

5.2.3. Party(ies) Responsible for Implementation

The Navy will be responsible for completing this mitigation measure.

5.2.4. Planned Implementation Schedule

In the event of inadvertent discovery of unknown archaeological resources during construction, operation or maintenance, work will be stopped and the Navy will consult with the SHPO and affected tribes.

5.2.5. Planned Funding

This mitigation will be funded by the Navy.

¹ The NHPA was recodified in December 2014 as part of a larger effort to better organize statutes related to the National Park Service. The code covering NHPA Section 106 is now located in Section 306108 of Title 54 USC.

5.2.6. Mitigation-Specific Performance Criteria

The specific performance criteria for this measure will be established as part of the agreement implementing the mitigation measures, as developed by the Navy in consultation with the SHPO.

5.2.7. Monitoring and Tracking Mechanisms

Reporting requirements will be specified in the agreement between the Navy and SHPO.

5.2.8. Enforcement Measures

The SHPO will enforce this mitigation measure.

5.3. OTHER RESOURCES

No mitigation measures are proposed for reducing impacts on air quality, aesthetics, socioeconomics, and public health and safety because any impacts on these resources from the LWI and SPE projects are expected to be minimal for reasons discussed below. Mitigation and environmental protection measures for geology and soils, noise, land use and recreation, and transportation are described below.

5.3.1. Geology and Soils

Mitigation measures are not necessary for geological resources because the projects would have only minor direct impacts on geologically hazardous areas and would not involve contaminated soils. However, the projects will include environmental protection measures such as design of the construction roadway and laydown area to minimize impacts by locating these features in areas away from steep slopes and streams, to the extent practicable. A geotechnical design evaluation will be performed to avoid steeper slopes and properly grade the soil, especially in areas where seepage has been observed. Measures to minimize soil erosion are described in Section 2.3.

5.3.2. Noise

Maximum noise levels for the LWI and SPE projects will occur during use of an impact pile driver, and the noise levels will exceed allowable noise limits for the OSHA (90 dBA) and Navy Occupational Safety and Health (84 dBA) for an 8-hour period. This could potentially cause injury to construction personnel working at the sites. In such conditions, personal protective equipment will be required for personnel working in these areas.

Pile driving for SPE will result in noise levels in the community of Olympic View approximately equal to the WAC daytime (7:00 a.m. to 10:00 p.m.) limit of 60 dBA. Temporary construction noise during the hours of 7:00 a.m. to 10:00 a.m. is exempt from WAC noise requirements. The WAC residential limit for nighttime (50 dBA) will not be exceeded because pile driving will occur only during daylight hours (**MM10a**).

For both LWI and SPE, due to intervening terrain and vegetation, residential areas on NAVBASE Kitsap Bangor and in the community of Vinland will not experience adverse noise impacts; noise levels will not exceed the WAC limits. Residential properties on the western

shore of Hood Canal will be able to hear pile driving noise but levels will not exceed noise levels above the WAC daytime or nighttime limits, in part because pile driving will not occur at night. The Navy will notify the public about upcoming construction activities and noise at the beginning of each construction season (**MM 10b**).

5.3.3. Air Quality

No mitigation measures are necessary, as the projects would not have an adverse impact on air quality. The project sites are in an attainment area for all six criteria pollutants. These projects would comply with the national and state ambient air quality standards.

5.3.4. Land Use and Recreation

The LWI and SPE projects are consistent with land use plans and policies, and there would only be short-term, adverse noise impacts on land use and recreation on the western shore of Hood Canal during construction. Noise levels on the western shore of Hood Canal will not exceed environmental noise standards; in addition, the WAC provides an exemption for construction noise originating from temporary construction sites. These projects would be consistent with the NAVBASE Kitsap Bangor Master Plan and Integrated Natural Resources Management Plan. There are no other regulations pertaining to land use or recreation applicable to this alternative. The Navy will implement the following mitigation measures: Construction activities will not be conducted during the hours of 10:00 p.m. to 7:00 a.m.; pile driving will occur only during daylight hours (**MM 10a**); the Navy will notify the public about upcoming construction activities and noise at the beginning of each construction season (**MM 10b**); and the Navy will develop a local Notice to Mariners to establish uniform procedures to facilitate the safe transit of vessels operating in the project vicinity (**MM 11a**).

5.3.5. Aesthetics

While the project will result in changes in the viewshed, these changes will not be out of character with existing conditions. Therefore, no mitigation measures are necessary. There are no regulations pertaining to visual resources or aesthetics.

5.3.6. Socioeconomics

As there will be no adverse environmental impacts on the human population from construction or operation of the LWI or SPE, no mitigation measures are necessary.

Construction may impact adult salmon and steelhead that could be harvested by the tribes because pile driving (hammer and vibratory) would be conducted during adult salmon and steelhead return to Hood Canal, which may cause the salmon and steelhead to move to a different location within Hood Canal. This would not result in a net loss of tribal resources, but could increase the time allocated to observe the tribes' fishing rights.

5.3.7. Traffic

5.3.7.1. NOTICE TO MARINERS (MM 11A)

During construction, the projects will result in increased marine vessel traffic. The Navy will develop a local Notice to Mariners to establish uniform procedures to facilitate the safe transit of vessels operating in the project vicinity.

5.3.7.2. BARGE TRAFFIC (MM 11B)

Construction vessel traffic for the LWI and SPE projects would result in an average of 26 additional openings of the Hood Canal Bridge per month, resulting in total traffic delays of 13 hours per month. This would have an adverse impact on travelers crossing the Hood Canal Bridge on State Route (SR)-104. Impacts on motorists would be minimized by scheduling bridge openings during non-peak traffic hours (6:00 to 8:30 a.m. and 3:30 to 6:00 p.m., Monday through Friday) to the extent possible. The increase in weekly barge trips and associated bridge openings would not appreciably increase vessel traffic levels in the project area. This level of vessel traffic is not expected to adversely impact vessel transit routes in Hood Canal or Puget Sound. Potential impacts on vessel traffic would be minimized by the U.S. Coast Guard issuing, at the Navy's request, Notices to Mariners at the beginning of each construction season and for bridge openings. Operation of the LWI project would not result in additional vessel traffic on Hood Canal, so only the operational impacts of the SPE (two openings of the Hood Canal Bridge per month) would occur over the long term.

6.0 COMPENSATORY AQUATIC MITIGATION (MM 12)

6.1. INTRODUCTION

The proposed actions will result in the loss and shading of eelgrass habitat, impacts on sensitive species, including movement of salmonids, and other long-term impacts on marine habitats and species. The proposed actions also will require Section 10 permits under the Rivers and Harbors Act (LWI and SPE projects), a 404 permit from USACE (LWI project only), and a CWA Section 401 water quality certification from WDOE (LWI and SPE projects). To receive permits the proposed actions must comply with *Compensatory Mitigation for Losses of Aquatic Resources, Final Rule* adopted on April 10, 2008 (USACE and USEPA 2008).

6.2. REGULATORY OVERVIEW

Compensatory Mitigation is the term given to projects or plans undertaken to offset “unavoidable adverse environmental impacts which remain after all appropriate and practicable avoidance and minimization has been achieved.” Compensatory mitigation involves actions taken to offset unavoidable adverse impacts on wetlands, streams, and other aquatic resources. For impacts authorized under a Section 404 permit, compensatory mitigation is not considered until after all appropriate and practicable steps have been taken to first avoid and then minimize adverse impacts on the aquatic ecosystem pursuant to 40 CFR Part 230 (i.e., the CWA Section 404(b)(1) Guidelines). WDOE also considers compensatory mitigation when issuing a CWA Section 401 water quality certification.

Compensatory mitigation is required for permits authorized by the CWA Section 404 and other Department of the Army permits. The 1990 Section 404 Mitigation Memorandum of Agreement (MOA) signed by the USEPA and USACE established procedures for implementing existing Section 404 regulatory requirements. In particular, the MOA set forth the process by which USACE will comply with the Section 404(b)(1) Guidelines when considering impacts and mitigation within the context of Standard Permit (Individual Permit) applications. Only when USACE is satisfied that an applicant has taken all steps to first avoid the impact altogether and second to minimize impacts, will USACE consider mitigation. When determining the level of appropriate mitigation, USACE considers the type of aquatic resource impacted and its functions. Appropriate mitigation generally means in-kind mitigation and the goal is no net loss in aquatic resource functions.

Compensatory Mitigation for Losses of Aquatic Resources, Final Rule (USACE and USEPA 2008) clarifies the use of mitigation banks and ILF programs and identifies the benefits of these mechanisms for providing compensatory mitigation. The rule allows for mitigation banks, approved ILF programs, and permittee responsible mitigation.

Compensatory Mitigation for Losses of Aquatic Resources, Final Rule emphasizes the use of a watershed approach to compensatory mitigation. The watershed approach involves consideration of several factors to assure proper implementation:

- Watershed needs and Compensatory Mitigation projects to address those needs,
- Landscape scale,
- Historic and potential aquatic resource conditions,

- Past and projected aquatic resource impacts, and
- Terrestrial connections between aquatic resources.

The changes to the regulations for compensatory mitigation are intended to increase the Compensatory Mitigation project success rate and improve the health of the aquatic resources in mitigated areas. The Compensatory Mitigation for Losses of Aquatic Resources, Final Rule was developed to provide better aquatic resource mitigation than the traditional focus on onsite/in-kind, which may not always be feasible or appropriate mitigation. Any proposed activity that impacts aquatic resources still needs to be addressed in the following order:

- Avoid. Proposed impacts must be avoided to the maximum extent possible.
- Minimize. Impacts that cannot be avoided should be minimized.
- Compensate for remaining impacts. Impacts that cannot be avoided must be compensated for through compensatory mitigation.

The Compensatory Mitigation for Losses of Aquatic Resources, Final Rule establishes a hierarchy or preference for Compensatory Mitigation:

- Mitigation Banks,
- ILF Programs, and
- Permittee-Responsible Mitigation.

The Navy has authority to participate in ILF programs and Mitigation Banks through the Sikes Act and DoD Natural Resource Policy Guidance.

The HCCC has established an ILF program for Hood Canal (HCCC 2014). Mitigation banks and ILF programs are forms of “third-party” compensation because a third party, such as a bank, or ILF sponsor assumes responsibility for the implementation and success of the compensatory mitigation. The emphasis on this rule is that the compensatory mitigation should be determined based on the specific details of the impacted aquatic resources, the watershed, and viability of various Compensatory Mitigation projects that could mitigate the impacts. The changes implemented by this rule should improve the efficiency, predictability, and success rate of Compensatory Mitigation projects. The rule provides for improved review of mitigation and anticipates enhanced mitigation success based on:

- The use of effective standards based on best available science that should increase the success rate of mitigation projects,
- Increased public participation that should lead to more input and ideas for proposed projects, and
- More uniform standards that should increase the viability of mitigation banks and ILF programs compared to the more traditional permittee-responsible mitigation.

6.3. SUMMARY OF IMPACTS REQUIRING COMPENSATORY MITIGATION

The proposed LWI project would be subject to permits under Section 404 of the CWA because construction of the shoreline abutments would require excavation of sediments below the MHHW water line; the affected area would include 24 square feet (2 square meters) of

permanent fill in water of the U.S. represented by the LWI abutment stair landings. In addition, construction and operation of the LWI structures would impact eelgrass beds. However, the Navy's analysis indicates that the bents (rows of pilings) installed for both the LWI and SPE projects would not function as fill as defined by 33 CFR Part 323. Additionally, the proposed project designs include at least 20 feet between bents. As discussed in Section 3.1.2.1.2 of the EIS, the support piles installed for the LWI and SPE would slightly alter current speeds beneath the piers, which would cause minor erosion of fine-grained sediments near some piles impacted by turbulent flows, as well as settling and accumulation of fine-grained sediments at the base of other piles (Chiew and Melville 1987). Over the lifetime of the LWI and SPE, tidal currents would result in a gradual coarsening of surface sediments and thin scouring initially around the perimeter of each pile, and groups of piles (Sumer et al. 2001). However, shells and barnacles that accumulate on the piles would also slough off over time and contribute to the sediment content below the piles. The loss of fine-grained sediment would be offset by the accumulation of shell and barnacle particles. These two processes would result in no net impact on seafloor bathymetry below the piles, although there would be minor, localized coarsening of sediment particle size.

Construction and operation of the LWI and SPE pier structures, and relocation of PSBs and anchors, would not be expected to cause appreciable erosion or deposition of sediments within the project area or interfere with longshore sediment transport and delivery processes (cbec 2013). This conclusion is supported by the Golder Associates (2010) study, which concluded that the presence of other Navy structures along the Bangor shoreline has not caused appreciable changes in the morphology of the shoreline.

The proposed projects will impact aquatic resources, which will be mitigated in accordance with the Compensatory Mitigation for Losses of Aquatic Resources, Final Rule (USACE and USEPA 2008). The impacts and mitigation are summarized in Tables 2 and 3.

Table 2. Compensatory Mitigation for LWI Impacts on Aquatic Habitat and Waters of the U.S.

LWI Impact	LWI Alternative 2 Area	LWI Alternative 3 Area	LWI Anticipated Mitigation ¹
Habitat displaced by piles and/or anchors in shallow water (< 30 feet [10 meters])	6,000 square feet (557 square meters)	68 square feet (6 square meters)	Mitigation for loss of aquatic resources will be provided in accordance with the Compensatory Mitigation Rule. A final Mitigation Action Plan demonstrating no net loss of aquatic resources will be submitted prior to issuance of a USACE permit.
Over-water area (shading) in shallow water ²	17,220 square feet (1,600 square meters)	4,080 square feet (379 square meters)	Mitigation will be provided to compensate for loss of habitat function and value. Final mitigation will be included in the final Mitigation Action Plan.
Eelgrass covered by steel plate anchors and piles	1,039 square feet (96 square meters)	N/A	Mitigation will be included as a component of the mitigation for aquatic resources.

Table 2. Compensatory Mitigation for LWI Impacts on Aquatic Habitat and Waters of the U.S. (continued)

LWI Impact	LWI Alternative 2 Area	LWI Alternative 3 Area	LWI Anticipated Mitigation ¹
Eelgrass covered by buoy mooring anchors or degraded by PSB and buoy grounding	N/A	0.013 acre (0.0054 hectare)	Mitigation will be included as a component of the mitigation for aquatic resources.
Fill in waters of the U.S. (shoreline abutment stair landings)	24 square feet (2 square meters)	24 square feet (2 square meters)	Mitigation for loss of aquatic resources ³ will be provided in accordance with the Compensatory Mitigation Rule. A final Mitigation Action Plan demonstrating no net loss of aquatic resources will be submitted prior to issuance of a USACE permit.
Excavation in waters of the U.S. (shoreline abutments)	8,000 square feet (740 square meters)	8,000 square feet (740 square meters)	Mitigation for loss of aquatic resources ³ will be provided in accordance with the Compensatory Mitigation Rule. A final Mitigation Action Plan demonstrating no net loss of aquatic resources will be submitted to USACE as part of the permit application process.
Total ⁴	25,220 square feet (2,343 square meters)	12,080 square feet (1,120 square meters)	

N/A = not applicable; USACE = U.S. Army Corps of Engineers

1. Table shows the potential range of impacts considering all alternatives. Final mitigation requirements for the selected alternative will be determined through the CWA permitting process.
2. No full shading of eelgrass is expected from either alternative.
3. Impact is from excavation during construction of the abutments and concrete fill from the abutment stair landings.
4. Total is the sum of the overwater area plus the excavation for the abutments; the abutment stair landing fill areas are included in the excavation areas; all other items are included in the overwater shading area.

Table 3. Compensatory Mitigation for SPE Impacts on Aquatic Habitat and Waters of the U.S.

SPE Impact	SPE Alternative 2 Area	SPE Alternative 3 Area	SPE Anticipated Mitigation ¹
Habitat displaced by piles in deep water (> 30 feet [10 meters])	0.045 acre (0.018 hectare)	0.043 acre (0.017 hectare)	Mitigation for loss of aquatic resources will be provided in accordance with the Compensatory Mitigation for Losses of Aquatic Resources, Final Rule. A final Mitigation Action Plan demonstrating no net loss of aquatic resources will be submitted prior to issuance of a USACE permit.
Overwater area (full shading) in deep water (more than 30 feet below MLLW). There would be no shading shallower than 30 feet below MLLW.	1.0 acre (0.41 hectare)	1.6 acres (0.65 hectare)	Mitigation for loss of aquatic resources will be provided in accordance with the Compensatory Mitigation for Losses of Aquatic Resources, Final Rule. A final Mitigation Action Plan demonstrating no net loss of aquatic resources will be submitted prior to issuance of a USACE permit.

1. Table shows the potential range of impacts considering all alternatives. Final mitigation requirements for the selected alternative will be determined through the CWA permitting process. Habitat displaced by piles is included in the habitat in the overwater area. Project would not shade or displace shallow habitat.

6.4. HOOD CANAL IN-LIEU FEE PROGRAM

The use of an ILF Program remains the preferred compensatory mitigation approach for the unavoidable impacts on aquatic resources from the proposed action.

6.4.1. ILF Program Goal and Objectives

The primary goal of the HCCC ILF Program for Hood Canal is to increase aquatic resource functions in the Hood Canal watershed. This can be accomplished by improving existing mitigation requirements with rigorous site assessment and selection processes that fully support priorities for conserving and restoring Hood Canal. While mitigation seeks to generally offset the impacts of development projects resulting in no net loss, this ILF Program will add value to mitigation processes by implementing projects in a coordinated manner, consistent with existing regulations and legal limitations relating to mitigation. To accomplish this goal, the HCCC incorporated the following objectives into the ILF Program (HCCC 2011):

- Provide a viable option to ensure the availability of high-quality mitigation for unavoidable, site-specific impacts to freshwater wetlands and marine/nearshore aquatic resources in the Hood Canal watershed.
- Promote “net resource gain” (defined as restoration of ecological processes) and improved ecological functions of the Hood Canal watershed.
- Meet the needs and goals of the Hood Canal Integrated Watershed Management Plan approach and the HCCC members.
- Develop, in cooperation with environmental regulatory partners, an ecologically based site selection process to identify the most appropriate mitigation options that result in greater ecological benefit to the Hood Canal watershed than could be achieved through permittee responsible mitigation.
- Combine the mitigation requirements from individual permitted projects within a service area into larger mitigation sites.
- More efficiently and cost-effectively meet federal, state, and local regulatory requirements by creating a mechanism for fulfilling compensatory mitigation requirements.
- Select the best mitigation sites for the watershed through a rigorous analysis by a group of professional resource managers and local experts, drawing from local knowledge and best available science and analyses.
- Develop a self-sustaining ILF Program that identifies, prioritizes, and completes mitigation projects that result in a “net resource gain” on a watershed scale over time.
- Provide an effective and transparent accounting structure for collecting ILFs, disbursing project funds, and conducting compliance reporting, as required under 33 CFR 332.8.
- Work in an efficient and transparent manner with the Interagency Review Team, co-chaired by the USACE and WDOE, to review, analyze, and implement mitigation projects and enact amendments to the ILF Program.

The HCCC has four strategies to accomplish its goal and objectives. These strategies are to: restore aquatic resource functions; enhance existing aquatic resources; establish new functions where they no longer exist; and, under certain circumstances, preserve intact or fully functioning aquatic resource functions. Compensatory mitigation can take one of these four forms, in order of preference:

1. Restoration: returning a damaged aquatic resource to its original condition through restoration of habitat forming processes;
2. Creation: converting an area that has no significant aquatic resources into an aquatic resource area with all of the physical and biological characteristics to replace the area lost or damaged;
3. Enhancement: making changes or improvements to an aquatic resource to replace the functions or values performed by the resources lost or damaged; and
4. Preservation: protecting aquatic resources in an area that is equivalent to the area damaged, and that might otherwise be impacted or lost.

The mitigation strategy selected for each permitted impact will be based on an assessment of type and degree of disturbance at the landscape and/or drift cell scales. Restoration generally will be the first mitigation option considered because the likelihood of success is greater and the impacts on potential ecologically important uplands are reduced compared to enhancement or creation. Restoration also has potential to produce more substantial gains in aquatic resource functions compared to enhancement and preservation.

6.4.2. Hood Canal ILF Service Area

The service area for the Hood Canal ILF Program encompasses those portions of Water Resource Inventory Areas 14, 15, 16, and 17 draining to Hood Canal, defined by a line extending from Foulweather Bluff to Tala Point, south through the Great Bend to its terminus near the town of Belfair, Washington.

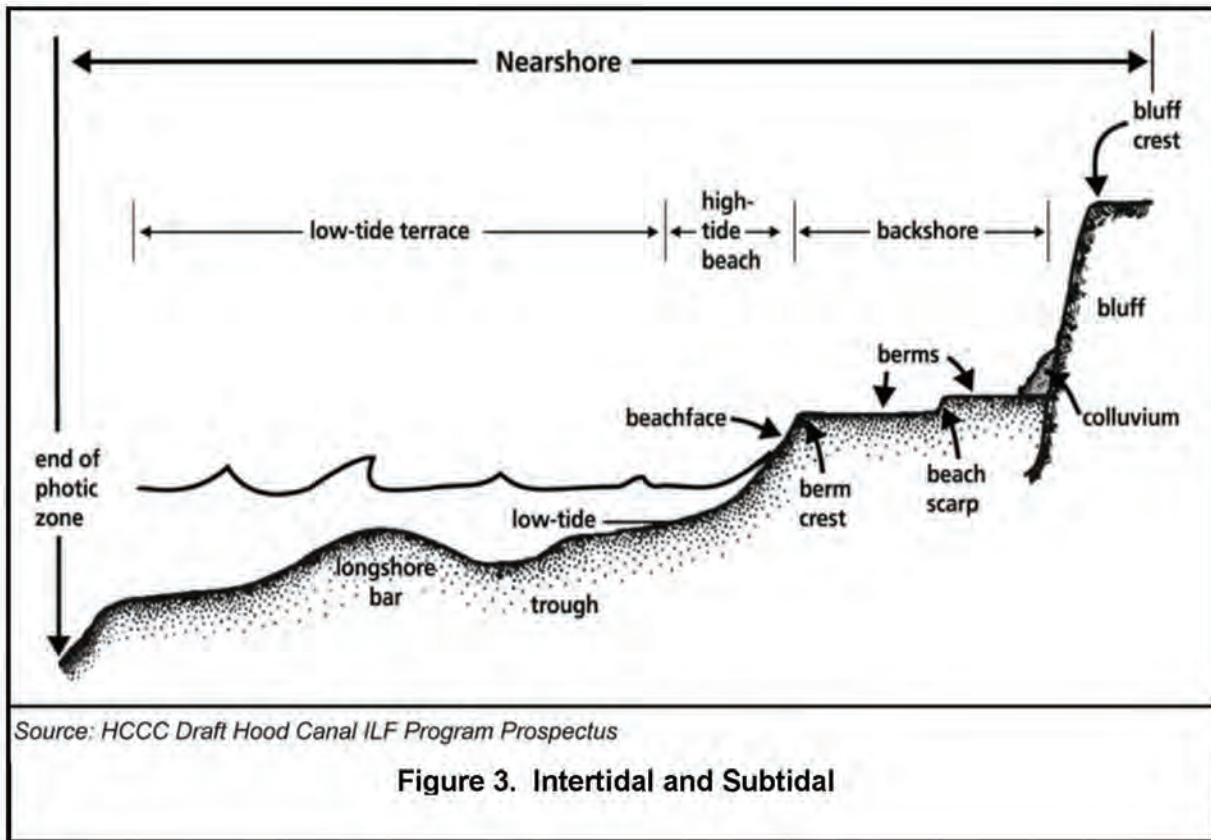
The service area is divided into two components for the purposes of this ILF Program:

1. Freshwater Environment, which generally includes areas landward of the marine riparian zone, including freshwater and estuarine wetlands and streams up to and excluding any National Park or National Forest Lands; and
2. Marine / Nearshore Environment, which extends from the marine riparian area at the top of the coastal bluffs to the adjacent aquatic intertidal and subtidal zones (Figure 3).

6.4.3. Navy's Use of the HCCC ILF Program

The Navy's use of the HCCC's ILF program would follow the requirements of the Final Instrument for the HCCC's ILF program, which was developed based on input from the IRT and prescribes the credit/debit methodology, fee calculation structure, and financial assurances for the program (HCCC 2012). Appendix C of the Final Instrument specifies the procedures for approval of an applicant's use of the program, including mitigation sequencing, and how the ILF program would implement the mitigation. In accordance with the Final Instrument and

appendices, the Navy, regulatory agencies, and ILF Program will undertake the following actions:



- The Navy will complete data collection and a preliminary site and impacts assessment, and provide this information to the applicable regulatory agencies and permitting entities for review.
- The applicable regulatory agencies and permitting entities will review the proposed development project to ensure impacts are avoided and minimized to the maximum extent practicable and all onsite mitigation options are exhausted.
- The permitting agencies will determine if the HCCC ILF Program provides the best option for compensating for unavoidable impacts; if so then the Navy, in cooperation with the Program Sponsor (the HCCC), will complete the site and impacts assessment to determine the amount of credits needed to offset the impact (or debit). This will constitute the ILF Use Plan. The Program Sponsor will review and confirm the ILF Use Plan, and informally consult with the IRT if appropriate. The ILF Use Plan will then be provided to the applicable regulatory agencies and permitting entities.
- The agencies will approve or deny the permit conditioned on purchasing credits from the HCCC ILF Program for mitigation.
- The Navy will pay mitigation fee to the HCCC ILF Program to buy credits to offset the project's unavoidable impacts.

- The statement of sale will be sent to Corps, Ecology, and any other applicable regulatory or permitting entities which issued the permit conditioned upon purchasing credits from the HCCC ILF Program.

After mitigation sequencing steps have occurred and mitigation has been assigned to the HCCC ILF Program, the following steps (covered in detail in subsequent appendices of the Instrument) describe how mitigation will be implemented:

- The HCCC ILF Program will review impacts and ecological needs at the appropriate, nested scale.
- The HCCC ILF Program will propose mitigation sites and project concepts , along with the draft Spending Agreement, to the Corps and Ecology.
- In consultation with the IRT, the Corps and Ecology will review and approve the sites and conceptual plans, and sign the Spending Agreement.
- The HCCC ILF Program will develop draft and final mitigation plan(s) and site protection instrument(s).
- In consultation with the IRT, the Corps and Ecology will review and approve final mitigation plan(s) and final site protection instrument(s).
- The HCCC ILF Program will implement the mitigation project(s).
- All subsequent steps related to credit fulfillment, site maintenance, monitoring/reporting, adaptive management, and site protection are listed and discussed in Appendices K to P of the Final Instrument.
- Once fees are collected from the applicant, the ILF program will have three years to secure a site and begin implementation of the mitigation action.

More information on the HCCC ILF Program can be found on the HCCC website:
<http://hccc.wa.gov/>.

7.0 PERMITTING AND CONSULTATION TERMS AND CONDITIONS

This section will be developed once consultations with NMFS and USFWS are complete.

This page is intentionally blank.

8.0 SUMMARY OF PROPOSED MEASURES TO AVOID, MINIMIZE, AND COMPENSATE FOR ENVIRONMENTAL IMPACTS ON AQUATIC RESOURCES

This section summarizes measures that the Navy will implement to avoid, minimize and compensate for impacts on aquatic resources. Integrated into the projects are design features and measures to avoid environmental impacts. Where avoidance is not possible, the designs have been modified to minimize those impacts. Design features include the following:

- For both projects, the number of piles and anchors was minimized while still meeting structural, safety, and security requirements.
- For LWI Alternative 2, the piers were designed to minimize overwater coverage and maximize light transmittance. The pier was limited to pedestrian access, which allows it to be narrower and have a grated deck, as well as fewer, more widely spaced piles.
- For LWI Alternative 2, a mesh anchoring system was developed that did not require dredging.
- For LWI Alternative 2, the mesh size was maximized to facilitate fish passage while still meeting security requirements.
- For LWI Alternative 3, the PSB pontoons would be fitted with “feet” to minimize disturbance of the seafloor when the pontoons bottom out at low tide.
- For both SPE alternatives, the pier extension was placed in deep water to minimize impacts on marine vegetation and habitat, and interference with nearshore fish migration.
- For both SPE alternatives, as many facilities as possible were sited on land versus on the pier to minimize the size of the pier.

Additional measures to avoid, minimize, or compensate for impacts on aquatic resources are described below by resource. Sections of the Mitigation Action Plan providing more detailed descriptions of these measures are cited. Please refer also to Table 6–1 for a summary of aquatic impacts and compensatory mitigation. Residual (i.e., following avoidance and minimization measures) impacts on habitat functions would be compensated for by implementation of the Navy’s compensatory aquatic habitat mitigation action, which employs a Hood Canal watershed approach, as described in Section 6.0.

8.1. HYDROGRAPHY

Impacts on hydrography will be avoided by limiting construction vessels to a construction corridor of 100 feet (30 meters) around the new structure (Section 2.1.2.4) and implementing work vessel grounding control measures (Section 2.1.2.5). Impacts on hydrography would be minimized by:

- Keeping the size of the proposed LWI piers and SPE to the minimum needed to provide the functions required;
- Establishing construction debris and pile removal control measures (Section 2.1.2.3);

- Instituting prop wash control measures (Section 2.1.2.4); and
- Preparing and implementing a mooring and anchoring plan to avoid underwater anchor and line drag (Section 2.1.2.6).

8.2. MARINE WATER QUALITY

Impacts on marine water and sediment quality will be avoided by preparing and implementing a SWPPP (Section 2.1.2.1) and limiting construction vessels to a construction corridor of 100 feet around the new structure (Section 2.1.2.4). Impacts on marine water quality would be minimized by:

- Implementing spill response control measures in the event of an accidental spill (Section 2.1.2.2);
- Establishing construction debris and pile removal control measures (Section 2.1.2.3);
- Instituting prop wash control measures (Section 2.1.2.4); and
- Preparing and implementing a mooring and anchoring plan (Section 2.1.2.6).

8.3. EELGRASS

Impacts on eelgrass will be avoided by:

- Keeping the size of the proposed LWIs and SPE to the minimum needed to provide the functions required;
- Limiting construction vessels to a construction corridor of 100 feet (30 meters) around the new structures (Section 2.1.2.4);
- Implementing work vessel grounding control measures (Section 2.1.2.5); and
- Avoiding spudding and anchoring in eelgrass beds (Section 5.1.2).

Impacts on eelgrass will be minimized by:

- Placing the SPE in deep waters;
- Limiting the width of the LWI piers that cross the eelgrass bed to the minimum needed to provide the functions required;
- Aligning the LWI piers perpendicular to the shoreline so that the piers cross the shortest length of eelgrass bed possible;
- Designing the PSB pontoons with feet to reduce the amount of eelgrass disturbed;
- Establishing construction debris and pile removal control measures (Section 2.1.2.3);
- Instituting prop wash control measures (Section 2.1.2.4); and
- Preparing and implementing a mooring and anchoring plan (Section 2.1.2.6).

Residual (i.e., following avoidance and minimization measures) impacts on eelgrass and its environmental functions would be compensated for by implementation of the Navy's compensatory aquatic habitat mitigation action as described in Section 6.0.

8.4. BENTHIC COMMUNITY

Impacts on benthic communities will be avoided by:

- Preparing and implementing a SWPPP (Section 2.1.2.1);
- Limiting construction vessels to a construction corridor of 100 feet (30 meters) around the new structure (Section 2.1.2.4); and
- Implementing work vessel grounding control measures (Section 2.1.2.5).

Impacts on benthic communities will be minimized by:

- Placing the SPE in deep waters;
- Limiting the width of the LWI piers that cross nearshore benthic habitats such as oyster beds to the minimum needed to provide the functions required;
- Aligning the LWIs perpendicular to the shoreline so that the piers cross the shortest length of nearshore benthic habitats possible;
- Designing the PSB pontoons with feet to reduce the amount of benthic habitat disturbed;
- Establishing construction debris and pile removal control measures (Section 2.1.2.3);
- Instituting prop wash control measures (Section 2.1.2.4); and
- Preparing and implementing a mooring and anchoring plan (Section 2.1.2.6).

Avoidance and minimization measures described above that are protective of eelgrass beds would also be protective of those benthic species which use eelgrass for habitat (e.g., Dungeness crabs). Residual (following avoidance and minimization measures) impacts on the benthic community and its environmental functions would be compensated for by implementation of the Navy's compensatory aquatic habitat mitigation action as described in Section 6.0.

8.5. MARINE FISH

Impacts on marine fish, including ESA-listed species, will be avoided by adhering to the established work window, except as noted, for this portion of Hood Canal (Section 2.2). Impacts on marine fish would be further minimized by:

- Limiting the width of the LWI piers that cross the migratory path of juvenile salmonids to the minimum needed to provide the functions required; and
- Deploying air bubble curtains or other noise attenuating device(s) during impact hammer operations for steel piles (Section 3.2.2).

Other avoidance and minimization measures described above for hydrography, water quality, and eelgrass would also be protective of marine fish habitats (Section 5.1.2).

8.6. MARINE MAMMALS AND BIRDS

Impacts on ESA-listed marine birds and MMPA-protected marine mammals would be avoided by the use of visual monitoring for marine mammals and marbled murrelets during construction and shut-down of pile driving when these species approach or enter areas where injury could

occur (Section 4.0). Impacts on marine mammals and birds would be minimized by deploying air bubble curtains or other noise attenuating device(s) during impact hammer operations (Section 3.2.2) and employing a soft-start approach during pile driving operations (Section 3.2.3). Other avoidance and minimization measures described above for hydrography, water quality, eelgrass, and marine fish would also be protective of marine mammal and bird aquatic habitats and food resources.

9.0 TRIBAL MITIGATION

This section will be developed once tribal mitigation has been determined.

This page is intentionally blank.

10.0 LIST OF PREPARERS

Government Preparers

- **Thomas Dildine**
Project Manager, Environmental Planner, NAVFAC Northwest
B.S. Landscape Architecture, 1999, University of Idaho
M.S. Environmental Science, 2004, Washington State University
- **Cindi Kunz**
Wildlife Biologist, NAVFAC Northwest
B.S. Wildlife Science, University of Washington
M.S. Wildlife Science, University of Washington
- **Danielle Buonantony**
Marine Resources Specialist, NAVFAC, Atlantic
M.E.M., Coastal Environmental Management, Duke University
B.S., Zoology, University of Maryland – College Park
- **David Grant**
Archaeologist, NAVFAC Northwest
B.A. Anthropology/Archaeology, University of Washington
M.A. Anthropology/Nautical Archaeology, Texas A&M University
- **Michael Slater**
Noise
B.S. Mechanical Engineering, 1985, Washington State University
M. Eng Acoustics, 1995, Pennsylvania State University
M.B.A., 2006, Colorado State University

Consultant Team

Leidos

- **Andrew Lissner**
Project Manager
B.S. Biology, 1973, University of Southern California
Ph.D. Biology, 1979, University of Southern California
30+ years experience
- **Ted Turk**
Technical Lead
B.A. Biology, 1970, Williams College
Ph.D. Ecology, 1978, University of California, Riverside, and San Diego State University
30+ years experience

➤ Charles Phillips

Hydrography, Marine Water Quality, Sediment
B.A. Biology, 1973, University of California, Santa Barbara
M.A. Biology, 1979, San Francisco State University
30 years experience

➤ Jennifer Wallin

Marine Vegetation, Plankton, Benthic Communities
B.S. Biology, 1995, Pacific Lutheran University
M.S. Environmental Toxicology, 1997, Clemson University
15 years experience

➤ Chris Hunt

Marine Fish
B.S. Biology, 1998, Oregon State University
M.S. Environmental Science, 2001, Oregon State University
13 years experience

➤ Thomas Dubé

Geology and Soils, Surface Water and Groundwater
B.S. Geology, 1983, California State University, Sacramento
M.S. Geological Sciences, 1987, University of Washington
27 years experience

➤ Bernice Tannenbaum

Threatened & Endangered Species, Marine Mammals, Marine Birds, Upland Wildlife
B.A. Zoology, 1969, University of Maryland
Ph.D. Ecology and Animal Behavior, 1975, Cornell University
30+ years experience

➤ Lorraine Gross

Cultural Resources
B.A. Anthropology, 1975, Pomona College
M.A. Anthropology (Archaeology), 1986, Washington State University
25+ years experience

➤ Celia McIntire

Editing, Word Processing, Graphics
B.A. Professional Writing, Minor: Earth and Planetary Sciences, 1995,
University of New Mexico
18 years experience

11.0 LITERATURE CITED

- cbec. 2013. Hydrodynamic and Sediment Transport Modeling of the NBK Bangor Waterfront - Draft Technical Report. Mitigation Planning Support for P-983 Waterfront Restricted Area Land Water Interface and P-834 Service Pier Extension, Naval Base Kitsap Bangor, Kitsap County, Washington. Prepared by cbec, inc., West Sacramento, CA. Prepared for U.S. Department of the Navy Naval Facilities Engineering Command Northwest (NAVFAC NW), Silverdale, WA. February 25, 2013.
- CEQ. 2011. Appropriate use of mitigation and monitoring and clarifying the use of Mitigated Findings of No Significant Impact. Memorandum for Heads of Federal Departments and Agencies. Council on Environmental Quality, Nancy H. Sutley, Chair, Washington, DC. January 14,
2011. http://ceq.hss.doe.gov/current_developments/docs/Mitigation_and_Monitoring_Guidance_14Jan2011.pdf.
- Chiew, Y.M., and B.W. Melville. 1987. Local scour around bridge piers. *Journal of Hydraulic Research*. 25(1): 15–26.
- Crawford, D. 2010. Dean Crawford, Hood Canal Bridge Supervisor, Washington State Department of Transportation. December 2010. Personal communication with Lynn Wall, Environmental Planner, NAVFAC NW, Silverdale, WA. Re: bridge openings.
- DoD (Department of Defense). 2010. United Facilities Criteria, Low Impact Development. UFC 3-210-10N.
- Fresh, K.L. 2006. Juvenile Pacific Salmon in Puget Sound. Puget Sound Nearshore Partnership Report No. 2006-06. Published by Seattle District, U.S. Army Corps of Engineers, Seattle, WA.
- Golder Associates. 2010. Coastal processes analysis for Devil's Hole Mitigation Site, Naval Base Bangor, P977 Project. Technical memorandum. Prepared by Golder Associates, Redmond, WA. Prepared for Otak, Inc., Kirkland, WA. February 23, 2010.
- HCCC (Hood Canal Coordinating Council). 2011. Prospectus Hood Canal Coordinating Council In Lieu Fee Compensatory Mitigation Program. Poulsbo, WA: Program Sponsor: Hood Canal Coordinating Council. July 29, 2011.
- HCCC. 2012. Hood Canal Coordinating Council In-Lieu Fee Program Instrument - Final. Poulsbo, WA; with technical assistance from Environmental Science Associates: Hood Canal Coordinating Council. June 15, 2012.
- HCCC. 2014. *In Lieu Fee Mitigation Program web page*. Hood Canal Coordinating Council, Poulsbo, WA. <http://hccc.wa.gov/In+Lieu+Fee+Mitigation+Program/default.aspx> (Accessed March 19, 2014).
- Navy (U.S. Department of the Navy). 2004. FY-2004 Naval Base Kitsap - Bangor Pest management plan. Final draft. Silverdale, WA.

NMFS. 2011. Endangered Species Act Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat consultation for the Second Explosives Handling Wharf at Naval Base Kitsap Bangor, Hood Canal. 2011/00658. National Marine Fisheries Service Northwest Region, Seattle, Washington. September 29, 2011.

Sumer, B.M., R.J.S Whitehouse, and A. Torum. 2001. Scour around coastal structures: a summary of recent research. *Coastal Engineering*. 44(2): 153–190.

USACE (U.S. Army Corps of Engineers). 2012. Approved work windows: Approved work windows in all marine/estuarine areas excluding the mouth of the Columbia River (Baker Bay) by tidal reference area - 14 August 2012. Accessed March 25, 2013.
[http://www.nws.usace.army.mil/Portals/27/docs/regulatory/ESA%20forms%20and%20temp%20lates/Marine%20Fish%20Work%20Windows%20\(8-14-12\).pdf](http://www.nws.usace.army.mil/Portals/27/docs/regulatory/ESA%20forms%20and%20temp%20lates/Marine%20Fish%20Work%20Windows%20(8-14-12).pdf)

USACE and USEPA. 2008. Compensatory Mitigation for Losses of Aquatic Resources - Final Rule. Federal Register Volume 73, Number 70, 19594 – 19705. April 10, 2008.

USEPA (U.S. Environmental Protection Agency). 2007. Developing your stormwater pollution prevention plan: A guide for construction sites. EPA 833-R-060-04. U.S. Environmental Protection Agency.

USEPA. 2009. Technical guidance on implementing the stormwater runoff requirements for Federal Projects under section 438 of the Energy Independence and Security Act. EPA 841-B-09-001. U.S. Environmental Protection Agency, Office of Water, Washington, D.C. December 2009. http://www.epa.gov/owow/NPS/lid/section438/pdf/final_sec438_eisa.pdf.

USFWS. 2012. Protocol for Marbled Murrelet Monitoring During Impact Pile Driving (Revised August 13, 2012). U.S. Fish and Wildlife Service Washington Fish and Wildlife Office, Lacey, WA. http://www.fws.gov/wafwo/pdf/MAMUMonProtocol_Aug2012.pdf

WDOE (Washington Department of Ecology). 2012. Stormwater Management Manual for Western Washington. Publication Number 12-10-030. Washington State Department of Ecology, Water Quality Program, Olympia, WA. August 2012.
<https://fortress.wa.gov/ecy/publications/summarypages/1210030.html>.

ATTACHMENT A-1

MARINE MAMMAL OBSERVATION RECORD FORM (Sample)

This page is intentionally blank.

Project Name: _____				Monitoring Location _____ (Pier Location, Vessel based, Land Location, other)								Page _____ of _____							
Date: _____				Vessel Name: _____								Time Effort Initiated: _____							
				Sighting Data								Time Effort Completed: _____							
Event Code	Sighting Number (1 or 1.1 if resight)	Time/Duration watching sighting (Start/End time if continuous)	WP # (every time a sighting is made)	Observer	Sighting cue	Species	Dist/Dir to Animal (from Observer)	Dist to Pile (btwn animal & pile)	# of Animals Group Size (min/max/best) # of Calves	Relative Motion/and Behavior Code (see code sheet)	Const Type During Sighting	Mitigation used during sighting?	Mitigation Type?	Visibility	% Glare	Weath Cond	Sea State and Wave Ht	Swell Dir	Behavior Change/Response to Activity/Comments
							m or km o	m or km	/ / — calves	opening closing parallel none Behavior Code: —————	PRE POST SSV SSI V I PC DP ST NONE	Y	DE	B P M G E			Light Mod Heavy	N or S W or E	
							m or km o	m or km	/ / — calves	opening closing parallel none Behavior Code: —————	PRE POST SSV SSI V I PC DP ST NONE	Y	DE	B P M G E			Light Mod Heavy	N or S W or E	
							m or km o	m or km	/ / — calves	opening closing parallel none Behavior Code: —————	PRE POST SSV SSI V I PC DP ST NONE	Y	DE	B P M G E			Light Mod Heavy	N or S W or E	
							m or km o	m or km	/ / — calves	opening closing parallel none Behavior Code: —————	PRE POST SSV SSI V I PC DP ST NONE	Y	DE	B P M G E			Light Mod Heavy	N or S W or E	
							m or km o	m or km	/ / — calves	opening closing parallel none Behavior Code: —————	PRE POST SSV SSI V I PC DP ST NONE	Y	DE	B P M G E			Light Mod Heavy	N or S W or E	
							m or km o	m or km	/ / — calves	opening closing parallel none Behavior Code: —————	PRE POST SSV SSI V I PC DP ST NONE	Y	DE	B P M G E			Light Mod Heavy	N or S W or E	
							m or km o	m or km	/ / — calves	opening closing parallel none Behavior Code: —————	PRE POST SSV SSI V I PC DP ST NONE	Y	DE	B P M G E			Light Mod Heavy	N or S W or E	

Sighting #:chronological number of sightings, If resight of same animal, then 1.1, 1.2, etc. WP (Waypoint)=GPS recording of lat/long, time/date stamp. Critical for vessel observers.

Sighting Form last revised October 10, 2012. POC-DoN, NAVFAC NW, Balla-Holder

Sighting Codes
(Sighting Cue & Behavior Codes)

Behavior codes

Code	Behavior	Definition
BR	Breaching	Leaps clear of water
CD	Change Direction	Suddenly changes direction of travel
CH	Chuff	Makes loud, forceful exhalation of air at surface
DI	Dive	Forward dives below surface
DE	Dead	Shows decomposition or is confirmed as dead by investigation
DS	Disorientation	An individual displaying multiple behaviors that have no clear direction or purpose
FI	Fight	Agonistic interactions between two or more individuals
FO	Foraging	Confirmed by food seen in mouth
MI	Milling	Moving slowly at surface, changing direction often, not moving in any particular direction
PL	Play	Behavior that does not seem to be directed towards a particular goal; may involve one, two or more individuals
PO	Porpoising	Moving rapidly with body breaking surface of water
SL	Slap	Vigorously slaps surface of water with body, flippers, tail etc.
SP	Spyhopping	Rises vertically in the water to "look" above the water
SW	Swimming	General progress in a direction. Note general direction of travel when last seen [Example: "SW (N)" for swimming north]
TR	Traveling	Traveling in an obvious direction. Note direction of travel when last seen [Example: "TR (N)" for traveling north]
UN	Unknown	Behavior of animal undetermined, does not fit into another behavior
Pinniped only		
EW	Enter Water (from haul out)	Enters water from a haul-out for no obvious reason
FL	Flush (from haul out)	Enters water in response to disturbance
HO	Haul out (from water)	Hauls out on land
RE	Resting	Resting onshore or on surface of water
LO	Look	Is upright in water "looking" in several directions or at a single focus
SI	Sink	Sinks out of sight below surface without obvious effort (usually from an upright position)
VO	Vocalizing	Animal emits barks, squeals, etc.
Cetacean only		
LG	Logging	Resting on surface of water with no obvious signs of movement

Sighting Form last revised October 10, 2012. POC-DoN, NAVFAC NW, Balla-Holden

Marine Mammal Species

Code	Marine Mammal Species
CASL	California Sea Lion
HSEA	Harbor Seal
STSL	Steller Sea Lion
HPOR	Harbor Porpoise
DPOR	Dall's Porpoise
ORCA	Killer Whale
HUMP	Humpback Whale
UNLW	Unknown Large Whale
OTHR	Other
UNKW	Unknown

Construction Type

Code	Activity Type
SSV	Soft Start (Vibratory)
SSI	Soft Start (Impact)
V	Vibratory Pile Driving (installation and extraction)
I	Impact Pile Driving
PC	Pneumatic Chipping
DP	Dead pull
ST	Stabbing
NONE	No Pile Driving
OTH	Other

Event

Code	Activity Type
E ON	Effort On
E OFF	Effort Off
PRE	Pre Watch
POST	Post Watch
SSV	Soft start-vibratory
SSI	Soft start-impact
WC	Weather Condition/Change
S	Sighting
M-DE	Mitigation Delay
M-SD	Mitigation Shutdown

Mitigation Codes

Code	Activity Type
DE	Delay onset of Pile Driving
SD	Shut down Pile Driving

Sighting Form last revised October 10, 2012. POC-DoN, NAVFAC NW, Balla-Holden

Visibility

Code	Distance Visible
B	Bad (<0.5km)
P	Poor (0.5 – 1.5km)
M	Moderate (1.5 – 10km)
G	Good (10 - 15km)
E	Excellent (>15km)

Glare

Percent glare should be the total glare of observers' area of responsibility. Determine if observer coverage is covering 90 degrees or 180 degrees and document daily. Then assess total glare for that area. This will provide needed information on what percentage of the field of view was poor due to glare.

Weather Conditions

Code	Weather Condition
S	Sunny
PC	Partly Cloudy
L	Light Rain
R	Steady Rain
F	Fog
OC	Overcast

Sea State and Wave Height

Use Beaufort Sea State Scale for Sea State Code. This refers to the surface layer and whether it is glassy in appearance or full of white caps. In the open ocean, it also takes into account the wave height or swell, but in inland waters the wave height (swells) may never reach the levels that correspond to the correct surface white cap number. Therefore, include wave height for clarity.

Code	Wave Height
Light	0 – 3 ft
Moderate	4 – 6 ft
Heavy	>6 ft

Swell Direction

Swell direction should be where the swell is coming from (S for coming from the south). If possible, record direction relative to fixed location (pier). Choose this location at beginning of monitoring project.

ATTACHMENT A-2

SEABIRD MONITORING DATA COLLECTION FORM (Sample)

This page is intentionally blank.

*R=resting, F=feeding/diving, P=preening, Y=flushing, T=transiting, N=nesting, O=other

This page is intentionally blank.

ATTACHMENT A-3

SEABIRD MONITORING SITE/TRANSECTS IDENTIFICATION FORM (Sample)

This page is intentionally blank.

Seabird Monitoring Site/Transect Identification Form (Sample)**Seabird
Monitoring
Site/Transect
Identification
Form**

Project Name

Dolphin repair

Monitoring Dates

November 8, 9, 10, 2012Number of Monitoring
Sites/Transects4

Insert aerial photo of entire monitoring project area. Identify each monitoring site/station reflecting 50 meter zones for each observer. For example, if there are two observers on a boat transect, the box will be 100 meters wide. Some monitoring stations will overlap and should be indicated here.



This page is intentionally blank.

ATTACHMENT B

BEAUFORT WIND SCALE

This page is intentionally blank.

**Table 1 – Beaufort Wind Scale develop in 1805 by Sir Francis Beaufort of England
(0 = calm to 12 = hurricane)**

Force	Wind (knots)	Classification	Appearance of wind effects on the water	Appearance of wind effects on land	Notes specific to on-water seabird observations
0	<1	Calm	Sea surface smooth and mirror like	Calm, smoke rises vertically	Excellent conditions, no wind, small or very smooth swell. You have the impression you could see anything.
1	1-3	Light air	Scaly ripples, no foam crests	Smoke drift indicates wind direction, still wind vanes	Very good conditions, surface could be glassy (Beaufort 0), but with some lumpy swell or reflection from forests, glare, etc.
2	4-6	Light breeze	Small wavelets, crests glassy, no breaking	Wind felt on face, leaves rustle, vanes begin to move	Good conditions, no whitecaps, texture/lighting contrast of water make murrelets hard to see. Surface could also be glassy or have small ripples, but with a short, lumpy swell, thick fog, etc.
3	7-10	Gentle breeze	Large wavelets, crests beginning to break, scattered whitecaps	Leaves and small twigs constantly moving, light flags extended	Surveys cease, scattered whitecaps present, detection of murrelets definitely compromised, a hit-or-miss chance of seeing them owing to water choppiness and high contrast. This could also occur at lesser wind with a very short wavelength, choppy swell.
4	11-16	Moderate breeze	Small waves 0.3 to 1.1m becoming longer, numerous whitecaps	Dust, leaves, and loose paper lifted, small tree branches move	
5	17-21	Fresh breeze	Moderate waves 1.1 to 2.0 m taking longer form, many whitecaps, some spray	Small trees begin to sway	

This page is intentionally blank.

ATTACHMENT C

CHAIN OF CUSTODY RECORD FORM

This page is intentionally blank.

Chain of Custody Record				
Date and Time of Collection:	Duty Station:	Collection By:		
Source of Specimen (Person and/or Location) Found At:	Project Name:			
Item No:	Description of Specimen (include Species and Tag Number):			
Item No:	From: (Print Name, Agency)	Release Signature:	Release Date:	Delivered via: FEDEX U.S. Mail In Person Other:
	To: (Print Name, Agency)	Receipt Signature:	Receipt Date:	
	To: (Print Name, Agency)	Receipt Signature:	Receipt Date:	
Item No:	From: (Print Name, Agency)	Release Signature:	Release Date:	Delivered via: FEDEX U.S. Mail In Person Other:
	To: (Print Name, Agency)	Receipt Signature:	Receipt Date:	

This page is intentionally blank.

APPENDIX D

NOISE ANALYSIS

TABLE OF CONTENTS

APPENDIX D.....	D-1
1.0 INTRODUCTION.....	D-1
2.0 SOUND VS. NOISE	D-3
3.0 DESCRIPTION OF NOISE SOURCES	D-3
3.1. EXISTING NOISE LEVELS	D-3
3.1.1. LWI Project Sites	D-4
3.1.2. Service Pier Extension Project site.....	D-4
3.2. CONSTRUCTION NOISE SOURCES.....	D-5
4.0 PROXY SOURCE LEVELS	D-6
4.1. UNDERWATER SOURCE LEVELS	D-6
4.2. AIRBORNE SOURCE LEVELS	D-6
4.3. PROXY LEVEL DETERMINATION METHODOLOGY.....	D-9
4.3.1. RMS Values	D-9
4.3.2. SPL Values.....	D-9
4.3.3. SEL Values.....	D-10
4.4. ATTENUATION.....	D-11
4.5. ASSUMPTIONS	D-13
4.6. METHODOLOGY.....	D-14
4.6.1. Underwater Propagation.....	D-14
4.6.2. Airborne Propagation	D-15
4.6.3. Masking Effects.....	D-15
4.6.4. Calculation of Masking Distance for Impact Pile Driving	D-16
5.0 DEFINITIONS	D-17
6.0 LITERATURE CITED.....	D-18

LIST OF TABLES

Table D-1. Definitions of Acoustical Terms	D-2
Table D-2. Representative Underwater Noise Levels of Anthropogenic Sources.....	D-5
Table D-3. Impact and Vibratory Pile Driving Projects Evaluated for 36-inch Steel Pipe Proxy Source Levels (Underwater).....	D-7
Table D-4. Impact and Vibratory Pile Driving Projects Evaluated for 24-inch Steel Pipe Proxy Source Levels (Underwater).....	D-8
Table D-5. Impact Pile Driving Projects Evaluated for 18-inch Square Concrete Proxy Source Levels (Underwater)	D-8
Table D-6. Impact and Vibratory Pile Driving Projects Evaluated for Proxy Source Levels (airborne - unweighted).....	D-9
Table D-7. Underwater Pile Driving Source Levels (unattenuated).....	D-10
Table D-8. Airborne Pile Driving Source Levels	D-11
Table D-9. Values to Substantiate 8 dB Attenuation.....	D-12
Table D-10. Summary of Pile Numbers and Active Driving / Proofing Days Modeled	D-13

This page is intentionally blank.

1.0 INTRODUCTION

Bioacoustics, or the study of how sound affects living organisms, is a complex and interdisciplinary field that includes the physics of sound production and propagation, the source characteristics of sounds, and the perceptual capabilities of receivers. This Appendix is intended to introduce the reader to the basics of sound measurements and sound propagation.

Sound is an oscillation in pressure, particle displacement, or particle velocity, as well as the auditory sensation evoked by these oscillations, although not all sound waves evoke an auditory sensation (i.e., they are outside of an animal's hearing range) (Acoustical Society of America 1994). Sound may be described in terms of both physical and subjective attributes. Physical attributes may be directly measured. Subjective (or sensory) attributes cannot be directly measured and require a listener to make a judgment about the sound. Physical attributes of a sound at a particular point are obtained by measuring pressure changes as sound waves pass. The following material provides a short description of some of the basic parameters of sound.

Sound can be characterized by several factors, including frequency, intensity, and pressure (Richardson et al. 1995). Sound frequency (measured in hertz [Hz]) and intensity (amount of energy in a signal [watts per meter²]) are physical properties of the sound which are related to the subjective qualities of pitch and loudness (Kinsler et al. 1999). Sound intensity and sound pressure (measured in pascals [Pa]) are also related; of the two, sound pressure is easier to measure directly, and is therefore more commonly used to evaluate the amount of disturbance to the medium caused by a sound ("amplitude").

Because of the wide range of pressures and intensities encountered during measurements of sound, a logarithmic scale known as the decibel (dB) is used to evaluate these properties; in acoustics, "level" indicates a sound measurement in decibels. The dB scale expresses the logarithmic strength of a signal (pressure or intensity) relative to a reference value of the same units. This document reports sound levels with respect to sound pressure only. Each increase of 20 dB reflects a ten-fold increase in signal pressure. In other words, an increase of 20 dB means ten times the pressure, 40 dB means one hundred times the pressure, 60 dB means one thousand times the pressure, and so on.

The sound levels in this document are given as sound pressure levels (SPLs). For measurements of underwater sound, the standard reference pressure is 1 micropascal (μPa , or 10^{-6} pascals), and is expressed as "dB re 1 μPa ." For airborne sounds, the reference value is 20 μPa , expressed as "dB re 20 μPa ." Sound levels measured in air and water are not directly comparable, and it is important to note which reference value is associated with a given sound level.

Airborne sounds are commonly referenced to human hearing using a method which weights sound frequencies according to measures of human perception, de-emphasizing very low and very high frequencies which are not perceived well by humans. This is called A-weighting, and the decibel level measured is called the A-weighted sound level (dBA). A similar method has been proposed for evaluating underwater sound levels with respect to marine mammal hearing. While preliminary weighting functions for marine mammal hearing have been developed (Southall et al. 2007; National Marine Fisheries Service [NMFS] 2013), they are not yet applied

to sound exposure from pile driving activities. Therefore, underwater sound levels given in this document are not weighted and evaluate all frequencies equally.

Table D–1 summarizes common acoustic terminology. Two of the most common descriptors are the instantaneous peak SPL and the root mean square (RMS) SPL. The peak SPL is the instantaneous maximum or minimum over- or under-pressure observed during each sound event and is presented in dB re 1 μPa peak. The root mean square level is the square root of the energy divided by a defined time period, given as dB re 1 μPa RMS.

Table D–1. Definitions of Acoustical Terms

Term	Definition
Decibel [dB]	A unit describing the amplitude of sound, equal to 20 times the logarithm to the base 10 of the ratio of the pressure or intensity of the sound measured to the appropriate standard reference value. This document uses only sound pressure measurements to calculate decibel levels. The reference pressure for water is 1 micropascal (μPa) and for air is 20 μPa (approximate threshold of human audibility).
Sound Pressure Level [SPL]	Sound pressure is the force per unit area, usually expressed in micropascals (or 20 micro Newtons per square meter), where 1 Pascal is the pressure resulting from a force of 1 Newton exerted over an area of 1 square meter. Sound pressure level is the quantity that is directly measured by a sound level meter, and is expressed in decibels referenced to the appropriate air or water standard.
Frequency, Hz	Frequency is expressed in terms of oscillations, or cycles, per second. Cycles per second are commonly referred to as hertz (Hz). Typical human hearing ranges from 20 Hz to 20,000 Hz; hearing ranges in non-humans are widely variable and species specific.
Peak Sound Pressure (unweighted), dB re 1 μPa peak	The maximum absolute value of the instantaneous sound pressure expressed as dB re 1 μPa peak.
Root Mean Square [rms], dB re 1 μPa rms	The rms level is the square root of the pressure divided by a defined time period, expressed in decibels. For impulsive sounds, the rms has been defined as the average of the squared pressures over the time that comprise that portion of waveform containing 90 percent of the sound energy for one impact pile driving impulse. For non-impulsive sounds, rms energy represents the average of the squared pressures over the measurement period and is not limited by the 90 percent energy criterion. Expressed as dB re 1 μPa .
Sound Exposure Level [SEL], dB re 1 μPa^2 sec	Sound exposure level is a measure of energy. Specifically, it is the dB level of the time integral of the squared-instantaneous sound pressure, normalized to a 1-second period. It can be an extremely useful metric for assessing cumulative exposure because it enables sounds of differing duration to be compared in terms of total energy.
Waveforms, μPa over time	A graphical plot illustrating the time history of positive and negative sound pressure of individual pile strikes shown as a plot of μPa over time (i.e., seconds).
Frequency Spectra, dB over frequency range	A graphical plot illustrating the frequency content over a given frequency range. Bandwidth is generally defined as linear (narrowband) or logarithmic (broadband) and is stated in frequency (Hz).
A-Weighted Sound Level, dBA	A frequency-weighted measure used for airborne sounds only. A-weighting de-emphasizes the low and high-frequency components of a given sound in a manner similar to the frequency response of the human ear and correlates well with subjective human reactions to noise. A-weighted levels are referenced to 20 μPa unless otherwise noted.
Ambient Noise Level	The background noise level, which is a composite of sounds from all sources near and far. The normal or existing level of environmental noise at a given location, given in dB referenced to the appropriate pressure standard.

While the body of knowledge on the impacts of pile driving noise on marine and terrestrial species has expanded significantly in the past few years, monitoring and research are still needed to better gauge both the scope and intensity of these impacts. The Navy has enhanced its approach for the selection of appropriate proxy source levels, acoustic propagation modeling, and understanding the potential behavioral and physiological effects on marine mammals, fish, sea turtles, and birds. This progress is facilitated by dedicated acoustic monitoring during active installation and experience removing a wide variety pile sizes and materials. Further, new peer-reviewed and grey literature from monitoring and studies both in the U.S. and internationally is helping to inform the Navy's analysis of environmental effects during infrastructure upgrades. Scientific research and recent biological opinions from regulatory agencies have suggested that current guidelines and criteria for marine species behavioral and physiological impacts may warrant review and revision.

For the assessment of potential impacts associated with the LWI and SPE projects, the Navy has considered previous analyses for pile driving projects in Puget Sound and Hood Canal, as well as standards for similar projects around the country. These analyses and standards were combined with the best available science and literature, real-world requirements for construction activities, and opinions from regulatory agencies. The assessment and resulting conclusions included in this document reflect these factors.

2.0 SOUND VS. NOISE

Sound may be purposely created to convey information, communicate, or obtain information about the environment. Examples of such sounds are sonar pings, marine mammal vocalizations/echolocations, tones used in hearing experiments, and small sonobuoy explosions used for submarine detection.

Noise is undesired sound (Acoustical Society of America 1994). Whether a sound is noise depends on the receiver (i.e., the animal or system that detects the sound). For example, small explosives and sonar used to locate an enemy submarine produce *sound* that is useful to sailors engaged in anti-submarine warfare, but is likely to be considered undesirable *noise* by marine mammals. Sounds produced by military training and construction activities are considered noise because they represent possible energy inefficiency and increased detectability, which are undesirable.

Noise also refers to all sound sources that may interfere with detection of a desired sound and the combination of all of the sounds at a particular location (ambient noise).

3.0 DESCRIPTION OF NOISE SOURCES

3.1. EXISTING NOISE LEVELS

Ambient noise in the vicinity of the Land-Water Interface (LWI) / Service Pier Extension (SPE) project is a composite of sounds from natural sources, and typical recreational and enterprise activities such as boating, jet skiing, and military ship traffic. Small powerboats generate peak narrow band SPLs of 150 to 165 dB at 3 feet (0.9 meter) in the 350 to 1,200 Hz region, with mean SPLs of 148 dB at 3 feet (0.9 meter) (Barlett and Wilson 2002). Fishing vessels can

generate peak spectral densities of 140 dB at 3 feet (0.9 meter) in the 250 to 1,000 Hz regime (Hildebrand 2004). Underwater sound from human activities includes ship traffic noise, use of sonar and echo sounders in commercial fishing to locate fish schools, industrial ship noise, and recreational boat use. Ship and small boat noise comes from propellers and other on-board mechanical equipment or fluid systems. Other sources of underwater noise at industrial waterfronts can come from cranes, generators, and electrical distribution facilities, as well as mechanized equipment operating on wharves or the adjacent shoreline.

In a study conducted in Haro Strait, San Juan Islands, data showed that the ambient half-hourly SPL ranged from 95 dB to 130 dB (Veirs and Veirs 2005), demonstrating the range over which localized human-generated noise can vary by specific locations and time periods. Carlson et al. (2005) measured the underwater baseline noise at Hood Canal Bridge and found that broadband (24 kilohertz [kHz] bandwidth) underwater noise levels ranged from 115 to 135 dB re 1 μPa . The Washington State Department of Transportation (WSDOT) summarized underwater broadband (20 Hz to 20 kHz) noise over three consecutive 24-hour periods at ferry terminals in Mukilteo, Port Townsend, Anacortes, Edmonds, and Seattle (Laughlin 2014). Based on WSDOT's recent research, the broadband sound level was 124 dB at Mukilteo, 107 dB at Port Townsend, 133 dB at Anacortes, 123 dB at Edmonds, and 141 dB at Seattle.

3.1.1. LWI Project Sites

Existing noise levels at the LWI project site are expected to be similar to baseline underwater noise levels measured during a 30-day period along the developed portion of the Bangor waterfront (Slater 2009). The average broadband RMS noise level at the LWI project sites is approximately 114 dB re 1 μPa between 100 Hz and 20 kHz; the minimum was 103 dB RMS re 1 μPa and the maximum was 147 dB RMS re 1 μPa (Slater 2009). The primary source of noise was due to industrial activity along the waterfront (e.g., at the Explosives Handling Wharf-1 [EHW-1], Marginal Wharf, and Delta Pier), small boat traffic, and wind-driven wave noise. No substantial precipitation was noted during the study period, although this would undoubtedly contribute to noise during seasonal periods. Peak spectral noise from industrial activity was noted below a frequency of 300 Hz, with maximum levels of 110 dB re 1 μPa noted in the 125 Hz band. In the 300 Hz to 5 kHz range, average levels ranged between 83 and 99 dB re 1 μPa . Wind-driven wave noise dominated the background noise environment at approximately 5 kHz and above, and ambient noise levels flattened above 10 kHz.

Ambient underwater sound in the vicinity of EHW-1, approximately 1,500 feet (450 meters) from the north LWI and 5,900 feet (1,800 meters) from the south LWI, was measured during the Test Pile Program (TPP) in 2011. Average underwater sound levels ranged from 112 dB RMS re 1 μPa at mid-depth between 50 Hz and 20 kHz to 114 dB RMS re 1 μPa at deep depth (Illingworth & Rodkin 2012). For the purposes of noise analyses for the LWI project, the average background underwater noise level at the project area was considered to be 114 dB RMS re 1 μPa between 100 kHz and 20 kHz.

3.1.2. Service Pier Extension Project site

Some of the baseline underwater noise levels described above for LWI were measured at sample locations in the vicinity of the existing Service Pier (Slater 2009). Therefore, existing underwater

noise levels at Service Pier are expected to be similar to those described above for the LWI project sites. For the purposes of noise analyses for the SPE project, the average background underwater noise level at the project area was considered to be 114 dB RMS re 1 μPa between 100 kHz and 20 kHz.

3.2. CONSTRUCTION NOISE SOURCES

In-water construction activities associated with SPE Alternative 2 include impact and vibratory pile driving. The sounds produced by these activities fall into two sound types: impulsive (impact driving) and non-impulsive (vibratory driving). Distinguishing between these two general sound types is important because each sound type may cause different types of physical effects to marine species, particularly with regard to hearing (Ward 1997).

Impulsive sounds (e.g., explosions, seismic airgun pulses, and impact pile driving) are brief, broadband, atonal transient sounds which can occur as isolated events or be repeated in some succession (Southall et al. 2007). Impulsive sounds are characterized by a relatively rapid rise from ambient pressure to a maximal pressure value followed by a decay period that may include a period of diminishing, oscillating maximal and minimal pressures (Southall et al. 2007). Impulsive sounds generally have a greater capacity to induce physical injury compared with sounds that lack these features (Southall et al. 2007).

Non-impulsive sounds can be tonal, broadband, or both. They lack the rapid rise time and can have longer durations than impulsive sounds. Non-impulsive sounds can be either intermittent or continuous sounds. Examples of non-impulsive sounds include vessels, aircraft, and machinery operations such as drilling, dredging, and vibratory pile driving (Southall et al. 2007).

Table D–2 details representative noise levels of anthropogenic activities to provide context for this analysis.

Table D–2. Representative Underwater Noise Levels of Anthropogenic Sources

Noise Source	Source Level	Frequency Range	Reference
Dredging	161 – 186 dB RMS re: 1 μPa @ 1 meter	1 – 500 Hz	Richardson et al. 1995; DEFRA 2003; Reine et al. 2014
Wind Turbine	100 – 120 dB RMS re: 1 μPa @ 100 meters	30 – 200 Hz	Betke 2006; Nedwell et al. 2007
Small Vessel	141 – 175 dB RMS re: 1 μPa @ 1 meter	860 – 8,000 Hz	Galli et al. 2003; Matzner and Jones 2011; Sebastianutto et al. 2011
Large Ship	176 – 186 dB re: 1 $\mu\text{Pa}^2\text{sec}$ SEL @ 1 meter	20 – 1,000 Hz	McKenna et al. 2011
Airgun Array	255 – 262 dB peak re: 1 μPa @ 1 meter ¹	10 – 200 Hz	MacGillivray and Chapman 2005; Götz et al. 2009

¹Measurements = reported in both peak and peak-to-peak units.

4.0 PROXY SOURCE LEVELS

During construction of the LWI and SPE projects, underwater and airborne noise levels in the Action Areas would be elevated due to pile driving, vessel and boat traffic, and operation of heavy construction equipment. The greatest sound levels would be produced by impact driving hollow steel piles (WSDOT 2013). Some noise would be generated with construction support vessels, small boat traffic, and barge-mounted equipment such as cranes and generators, but this noise will typically not exceed existing underwater noise levels resulting from existing routine waterfront operations in the vicinity of the construction sites. Several non-pile driving construction activities would also occur at the project areas. Among them are relocation of mooring anchors; installation of Port Security Barrier [PSB] units, pier decking, and camels; and operation of cranes, power utility booms, and other equipment. While no in situ empirical data exist for these construction activities, they are expected to be significantly lower than those estimated for pile installation using an impact/vibratory pile driver. Although it is possible that sound could be transmitted from these activities along the piles' length and enter the water, underwater acoustic impacts from these construction operations are expected to be minimal.

In order to estimate in-air and underwater acoustic propagation from pile driving activities associated with the two projects, proxy source levels were developed based on data collected from several similar projects using 36- and 24-inch (90- and 60-centimeter) hollow steel piles and 18-inch (45-centimeter) concrete piles. Data from studies which met the following parameters were considered:

- Pile size and type: 36- and 24-inch diameter steel pipe piles; and 18-inch concrete piles
- Installation method: vibratory (steel piles only) and impact hammer
- Physical environment: similar to conditions in the waters off Naval Base (NAVBASE) Kitsap, Bangor

4.1. UNDERWATER SOURCE LEVELS

Tables D–3 through D–5 summarize the projects and sound levels used in the development of the underwater proxy levels. “Average” values were computed by converting selected SPL values (dB) into pressure values (Pa), summing them together in linear space, dividing by the total number, n , of selected piles, and converting the result back to SPL (dB). In following this approach, the proxy value represents the arithmetic average value for each pile type and size from applicable projects.

4.2. AIRBORNE SOURCE LEVELS

Review of the available literature provided two unweighted L_{max} levels, both from the NAVBASE Kitsap Bangor TPP (Table D–6). A maximum level of 112 dB re 20 μ Pa was measured for 36-inch piles, at the de facto measurement distance of 50 feet, and was therefore chosen as a conservative proxy value for piles of this size. A maximum level of 110 dB was measured for a single 24-inch steel pile, and was selected as the most representative value for modeling analysis.

Table D–3. Impact and Vibratory Pile Driving Projects Evaluated for 36-inch Steel Pipe Proxy Source Levels (Underwater)

Project	# piles	Hammer Type	Water Depth	RMS (dB re 1 µPa)	Peak (dB re 1 µPa)	SEL (dB re 1 µPa ² s)
IMPACT						
Mukilteo Test Piles ¹	2	diesel	23.9 ft (7.3 m)	weighted average		
				190	205	183
				average range		
				187 – 191	202 – 207	180-184
Anacortes Ferry ²	7	n/a	42 ft (12.8 m)	weighted average		
				192	209	185
				average range		
				181 – 193	205 – 211	183-186
NBK, Bangor Test Pile Program ³	4	diesel	43-88.3 ft (13.1-26.9 m)	weighted average		
				194	n/a	181
				average range		
				185 – 196	n/a	173-183
VIBRATORY						
Edmonds Ferry Terminal ⁴	2	n/a	19 ft (5.8 m)	range 162 – 163 ⁸	n/a	n/a
Anacortes Ferry Terminal ⁵	2		41.6 ft (12.7 m)	range 168 – 170 ⁸		
NBK, Bangor Test Pile Program ³	33		50-88 ft (13.7-26.8 m)	164; range 154 – 169		
Port Townsend Test Pile Project ^{6,7}	1		31 ft (9.5 m)	172; range 159 – 177		

¹WSDOT 2007a; ²WSDOT 2007b; ³Illingworth & Rodkin 2012; ⁴WSDOT 2011; ⁵WSDOT 2012; ⁶WSDOT 2010b;

⁷Laughlin 2010, personal communication; ⁸reference distance 36 feet (11 meters)

Data are insufficient to determine an unweighted airborne source level for 18-inch square concrete piles. In order to apply conservative but reasonable assumptions in the acoustic model, an airborne source level of 112 dB RMS re: 20 µPa at 15 m for impact driving of concrete piles during the second in-water work window under SPE Alternatives 2 and 3 was modeled.

A single 30-second measurement was made for 24-inch steel pipe piles during the TPP at NAVBASE Kitsap, Bangor. These data fit the overall trend of smaller and larger pile sizes. The limited data set for 24-inch steel pipe piles supports a reasonable representative proxy value of 92 dB RMS. Limited data are available 36-inch steel pipe piles. Therefore, 95 dB RMS (unweighted) was selected as the representative average proxy value for piles of this size.

Table D-4. Impact and Vibratory Pile Driving Projects Evaluated for 24-inch Steel Pipe Proxy Source Levels (Underwater)

Project	# piles	Hammer Type	Water Depth	RMS (dB re 1 µPa)	Peak (dB re 1 µPa)	SEL (dB re 1 µPa ² s)
IMPACT						
Bainbridge Island Ferry Terminal ¹	5	diesel	6.9 – 11.2 ft (2.1 – 3.4 m)	weighted average		
				195	206	181
				average range		
Friday Harbor Ferry Terminal ²	5	diesel; pneumatic, hydraulic	33 – 47 ft (10 – 14.3 m)	193-198	196 – 213	176-185
				weighted average		
				189	207	181
				average range		
				181-193	196 – 213	176-185
VIBRATORY						
Friday Harbor Ferry Terminal ³	1	n/a	8.5 ft (2.6 m)	162	n/a	n/a
Trinidad Pier Reconstruction ⁴	2		50 ft (15.2 m)	typical 160; range 158 – 178		
NBK, Bangor Test Pile Program ⁵	2		15.1 ft (4.6 m)	160; range 157 – 160		

¹WSDOT 2005a; ²WSDOT 2005b; ³WSDOT 2010c; ⁴ICF Jones and Stokes and Illingworth & Rodkin 2012;⁵HDR 2012**Table D-5. Impact Pile Driving Projects Evaluated for 18-inch Square Concrete Proxy Source Levels (Underwater)**

Project	# piles	Hammer Type	Water Depth	RMS (dB re 1 µPa)	Peak (dB re 1 µPa)	SEL (dB re 1 µPa ² s)
IMPACT						
Pier 2 Concord NWS	5	drop steam powered	23 ft (7 m)	weighted average		
				171	183	n/a
				average range		
Berkeley Marina	2	diesel	6.6-9.8 ft (2-3 m)	167-173	182-184	n/a
				weighted average		
				159	172	155
				average range		
				155-167	172-181	n/a
Berkeley Marina	3	diesel	6.6-9.8 ft (2-3 m)	weighted average		
				169	189	159
				average range		
				165-178	184-192	n/a

Source: ICF Jones and Stokes and Illingworth & Rodkin 2012

Table D–6. Impact and Vibratory Pile Driving Projects Evaluated for Proxy Source Levels (airborne - unweighted)

Pile Size / Type	Project	# piles	Distance	L_{max} dB re 20 μ Pa
IMPACT				
24-inch (60-centimeter) steel pipe piles	NBK, Bangor Test Pile Program	1	50 ft (15 m)	110
			400 ft (121.9 m)	95
		--	50 ft (15.2 m)	112
Pile Size / Type	Project	# piles	Distance	Average L_{eq} dB re 20 μ Pa
VIBRATORY				
24-inch steel pipe piles	NBK, Bangor Test Pile Program	1	50 ft (15.2 m)	92
			400 ft (121.9 m)	78
36-inch steel piles		--	50 ft (15.2 m)	95 (range 89 – 102)

Source: Illingworth & Rodkin 2012

The most recent A-weighted data from the 2013 Explosives Handling Wharf (EHW-2) acoustic monitoring report (Illingworth & Rodkin 2013) were reviewed in order to determine the proxy levels for modeling of airborne noise for receivers other than pinnipeds (Section 3.9 in the draft environmental impact statement [DEIS]). As with the unweighted airborne values described above, data were insufficient to determine an A-weighted source level for 18-inch (45-centimeter) square concrete piles. Therefore, a conservative but reasonable assumed value of 100 dBA was modeled (Table D–8).

4.3. PROXY LEVEL DETERMINATION METHODOLOGY

4.3.1. RMS Values

In order to best characterize a broad-base proxy SPL, average RMS pressures were computed from the reported SPL (dB) values, and then weighted by the number of pile strikes for a given pile. This weighting methodology estimated proxy values across multiple projects with differing numbers of piles or strike counts, and the effect of using weighting values ensures that a single project or pile does not overtly bias the result high or low. This proxy value represents the most likely value expected for individual pile strikes for SPE Alternative 2.

4.3.2. SPL Values

Average peak impact SPL values were selected from applicable projects, from which a weighted probability distribution function (PDF) was computed based on the number of pile strikes for

each pile. To ensure a conservative proxy value, a value representing the ninetieth percentile of the PDF was selected, meaning that for a typical impact pile driving project, 90 percent of all pile strikes would typically occur below this proxy value.

4.3.3. SEL Values

To avoid biasing the data high or low from a single pile or project, a weighted average was computed using the number of pile strikes, n , in the same manner as was followed for computation of impact RMS values. This approach ensured that a single project or pile does not bias the result high or low. The resulting proxy value represents the most likely value expected for individual pile strikes.

The data for each of the pile types were averaged¹, resulting in the unattenuated source levels that were incorporated into the acoustic model (Tables D–7 and D–8).

Table D–7. Underwater Pile Driving Source Levels (unattenuated)

Impact Driving			
Pile Size / Type	dB RMS re: 1 μPa @ 10 m	dB peak re: 1 μPa @ 10 m ¹	dB SEL re: 1 $\mu\text{Pa}^2 \text{ sec}$ @ 10 m
36-inch (90-centimeter) steel pipe	194	205	181
24-inch (60-centimeter) steel pipe	193	210	181
18-inch (45-centimeter) square concrete	170	184	159
Vibratory Driving			
Pile Size / Type	dB RMS re: 1 μPa @ 10 m	dB peak re: 1 μPa @ 10 m	dB SEL re: 1 $\mu\text{Pa}^2 \text{ sec}$ @ 10 m
36-inch steel pipe	166	n/a	n/a
24-inch steel pipe	161		

- Because 36- and 24-inch steel pipe piles may be installed on any active pile driving day during the first in-water work window under SPE Alternative 2, the more conservative (i.e., higher) source level for 36-inch piles was modeled, yielding the largest potential range to effect. The exception to this is dB peak source levels, where the values for 24-inch steel piles were greater than those for 36-inch piles; in this case, 210 dB peak was used for the model.

¹ All averages were calculated by converting decibel values (dB) to linear values (Pa) using the formula $y = 10^{(x_1/15)}$, where x_1 is the dB value. Linear values were averaged and the calculated value was re-converted to dB by $x_2 = 15 * \log_{10}(y_{avg})$.

Table D-8. Airborne Pile Driving Source Levels

Impact Driving			
Pile Size / Type	dB RMS re: 20 µPa @ 15 m		
	Unweighted	A-weighted	
36-inch (90-centimeter) steel pipe	112	100 ¹	
24-inch (60-centimeter) steel pipe	110 ¹		
18-inch (45-centimeter) square concrete	112		
Vibratory Driving			
Pile Size / Type	dB RMS re: 20 µPa @ 15 m		
	Unweighted	A-weighted	
36-inch steel pipe	95	96	
24-inch steel pipe	92 ¹	89 ¹	

1. Because 36- and 24-inch steel pipe piles may be installed on any active pile driving day during the first in-water work window under SPE Alternative 2, the more conservative (i.e., higher) source level for 36-inch piles was modeled, yielding the largest potential range to effect.

4.4. ATTENUATION

A bubble curtain or other noise attenuating device is assumed to be used to minimize noise levels during impact pile driving operations. Unconfined bubble curtain attenuators (Type I) emit a series of bubbles around a pile to introduce a high-impedance boundary through which pile driving noise is attenuated. A confined bubble curtain (Type II) places a shroud around the pile to hold air bubbles near the pile, ensuring they are not washed away by currents or tidal action. Reductions of 85 percent (approximately 17 dB) or more have been reported with the proper use of a Type II bubble curtain (Longmuir and Lively 2001), although reductions of 5 to 15 dB are more typical (Laughlin 2005).

The Navy performed a literature review and analysis in 2014 to compile the best available data for development of proxy source levels and reasonable attenuation values to use for acoustic modeling. The results of this effort are incorporated into Attachment 1: *Proxy Source Sound Levels and Potential Bubble Curtain Attenuation for Acoustic Modeling of Nearshore Marine Pile Driving at Navy Installations in Puget Sound*. The analysis for determination of appropriate attenuation values for acoustic modeling yielded an achievable level of attenuation for 36- and 48-inch steel pipe piles of 8 to 10 dB. In order to substantiate these values, a separate analysis of four specific events at NAVBASE Kitsap Bangor with a higher number of strikes (and thus a larger dataset) during the TPP was performed (Table D-9).

Table D-9. Values to Substantiate 8 dB Attenuation

Event Description	Bubble Curtain On / Off?	Pile Size	Date	Sensor	SPL (Avg)	# of Pile Strikes	Distance from Pile	Attenuation Results	Linear Conversion ¹								
TP # 2	on	36-inch	01 Sep 2011	mid	183	40	11 m	mid sensor difference									
				down	189			7 dB	2.939								
				mid	190	38		down sensor difference									
				down	196			7 dB	2.939								
	off			mid	180	47	20 m	mid sensor difference									
				down	181			8 dB	3.415								
				mid	188	40		down sensor difference									
				down	193			12 dB	6.31								
TP # 7	on	36-inch	10 Sep 2011	mid	181	38	10 m	mid sensor difference									
				down	191			9 dB	3.981								
				mid	190	33		down sensor difference									
				down	194			3 dB	1.585								
	off			mid	182	35	10 m	mid sensor difference									
				down	189			9 dB	3.981								
				mid	191	32		down sensor difference									
				down	193			4 dB	1.848								
								Average	3.375								
								Reconverted to dB RMS	7.924								

1. dB RMS attenuation values were converted to linear (Pa) values, averaged, and subsequently converted back to logarithmic values.

These analyses support an 8 dB reduction in sound levels for impact proofing of steel piles with bubble curtains during the first in-water work window. TPP data were inadequate to evaluate attenuation values for 24-inch piles, and no recommendation was made for this pile size in the literature review. Therefore, it is assumed that attenuation for 24-inch piles would be similar to attenuation for 36-inch and 48-inch piles. A bubble curtain will not be deployed during impact driving of concrete piles. Therefore, no attenuation value was assumed when calculating the estimated zone of influence for underwater noise from concrete piles.

4.5. ASSUMPTIONS

Assumptions that were used to complete the noise analysis are as follows:

- Up to 10 piles of any type could be installed during an active pile driving day.
- Vibratory driving would be the primary installation method for 36- and 24-inch (90- and 60-centimeter) steel piles; 18-inch (45-centimeter) concrete piles would be driven with an impact hammer (incorporating a cushion block).
- Proofing of steel piles, if needed, would require up to 200 strikes per pile; the actual amount of impact driving is expected to be significantly less than this number, yielding a conservative (i.e., larger than anticipated during actual pile installation) effect range for fish and marbled murrelet injury criteria (described in Sections 3.3 and 3.5, respectively).
- Installation of each concrete pile would require up to 300 strikes per pile.
- A bubble curtain will be used to minimize noise levels during impact pile driving of steel piles, with an average reduction of 8 dB from unattenuated pile driving source levels.
- No bubble curtain would be used during impact pile driving of concrete piles, or during vibratory driving of steel piles.

Table D–10 summarizes the number of piles and active driving / proofing days modeled for each alternative.

Table D–10. Summary of Pile Numbers and Active Driving / Proofing Days Modeled

DEIS Alternatives	Size / Type	Number	Number of Days	In-Water Work Window
LWI Alternative 2	24-inch (60-centimeter) steel	54 (north)	80	first
		82 (south)		
		120 (south - temporary only)		
	24-inch steel	17 (north) (in the dry)		
		17 (south) (in the dry)		
LWI Alternative 3	24-inch steel	17 (north) (in the dry) 17 (south) (in the dry)	30	first

Table D–10. Summary of Pile Numbers and Active Driving / Proofing Days Modeled (continued)

DEIS Alternatives	Size / Type	Number	Number of Days	In-Water Work Window
SPE Alternative 2	36-inch (90-centimeter) steel	230	125	first
	24-inch steel	50		
	18-inch (45-centimeter) concrete	105	36	second
SPE Alternative 3	24-inch steel	500	155	first
	18-inch concrete	160	50	second

Bolded text denotes preferred Alternatives; “in the dry” refers to piles driven on shore – no underwater noise is associated with these piles.

4.6. METHODOLOGY

4.6.1. Underwater Propagation

Modeling sound propagation is useful in evaluating noise levels to determine distance from the pile driving activity that certain sound levels may travel. The decrease in acoustic intensity as a sound wave propagates outward from a source is known as transmission loss (TL). The formula for transmission loss is:

$$TL = B * \log_{10} \left(\frac{R_1}{R_2} \right) + C * R_1,$$

where

B = logarithmic (predominantly spreading) loss,

C = linear (scattering and absorption) loss,

R₁ = range from source in meters,

R₂ = range from driven pile to original measurement location (generally 10 meters for underwater values, and 15 meters for airborne values).

The amount of linear loss (C) is proportional to the frequency of a sound. Due to the low frequencies of sound generated by impact and vibratory pile driving, this factor was assumed to be zero for all calculations and transmission loss was calculated using only logarithmic spreading. Therefore, using practical spreading (B = 15), the revised formula for transmission loss is TL = 15 log₁₀ (R₁/10).

The practical spreading loss model (TL = 15 log₁₀ (R₁/10)) discussed above was used to calculate the underwater propagation of pile driving noise in and around the proposed LWI and SPE project locations.

The estimated effects ranges for fish, marine mammals, and marine birds are detailed in Sections 3.3, 3.4, and 3.5, respectively, of the DEIS. The ensonified areas are assumed to take a

circular shape around the notional pile being driven; proximity to land features (e.g., shorelines) may result in some areas being “clipped” as sounds will attenuate as they encounter land or other solid obstacles. As a result, the ranges calculated may not actually be attained.

4.6.2. Airborne Propagation

Spherical spreading predicts that sound produced by a source will propagate through the environment and attenuate at a rate of 6 dB per doubling of distance. The mathematical formula for this model is the same as described above for underwater propagation. For airborne propagation, B (logarithmic loss) = 20 rather than 15 as for practical spreading. Airborne noise is analyzed in Section 3.9 of the DEIS.

4.6.3. Masking Effects

Masking is the increase in the detection threshold of sounds due to the presence of another sound such as the ambient or background sound level or an intermittent source such as pile driving. As determined by the Marbled Murrelet Hydroacoustic Science Panel II (SAIC 2012), masking of marbled murrelet vocalizations due to in-air pile driving noise has the potential to affect foraging behavior and efficiency because murrelets forage in pairs and it is assumed that foraging murrelets must be able to detect their partner’s calls within some distance. The amount of masking of a signal is measured by the critical ratio (i.e., signal-to-noise ratio) in the frequency range of the signal. For both TTS and noise masking of communication signals, the levels of concern are always dependent on existing ambient noise levels. Thus, these levels are site-specific and temporally variable. The USFWS (2013) has provided guidance on evaluating the significance of airborne masking effects for pile driving projects. “Typical” pile driving projects involve:

- Installation of 24-inch or 36-inch (60- or 90-centimeter) steel piles,
- Use of vibratory pile drivers,
- Use of impact pile drivers for proofing only, and
- Adherence to a 2-hour timing restriction (i.e., no pile driving 2 hours after sunrise and 2 hours before sunset during the breeding season).

Based on assumed source levels for each pile type required for LWI Alternative 2 and SPE Alternative 2 and 3, airborne masking distance for construction sites on the NAVBASE Kitsap Bangor waterfront was calculated using the airborne construction source level (72 dB re 20 μ Pa at 50 feet [15 meters]) measured for 24-inch (60-centimeter) steel piles during the TPP in 2011 (Illingworth & Rodkin 2012). Results of acoustic monitoring for EHW-2 construction have indicated that average airborne source levels during impact driving of 36-inch (90-centimeter) steel piles are the same as, and in some cases lower than, 24-inch steel piles; and levels for concrete piles are generally lower than for steel piles of comparable size. Therefore, the following analysis is appropriate to apply to all pile sizes and types being considered for the LWI and SPE. Definitions of terms used in the calculation are listed below and assumptions are discussed in detail in the science panel’s report (SAIC 2012).

4.6.4. Calculation of Masking Distance for Impact Pile Driving

Note: Calculations are in **bold font**.

Step 1: Determine source level of Marbled Murrelet *keer* call: Assumption, 95 dB re 20 μ Pa/Hz (spectrum level at 3 kHz, 1 meter from vocalizing bird) (SAIC 2012).

Step 2: Determine critical ratio (25 dB) and recognition differential (6 dB) for foraging pairs to recognize *keer* calls, total of 31 dB (SAIC 2012).

Step 3: Determine critical (maximum) distance bird pairs may be apart to not impinge on foraging communications: Assumption: 30 meters (SAIC 2012).

Step 4: Calculate received level of *keer* call at critical distance: **95 dB re 20 μ Pa/Hz – 20·log₁₀(30m/1m) = 65.5 dB re 20 μ Pa/Hz (spectrum level at 3 kHz)**.

- (a) Assumption: spherical spreading loss (6 dB per doubling of distance) over water
- (b) Maximum ambient noise level above which could cause impingement of communications: **65.5 dB re 20 μ Pa/Hz – 31 dB (recognition differential and critical ratio) = 34.5 dB re 20 μ Pa/Hz (spectrum level at 3 kHz)**. Any ambient noise or construction noise above this level could impinge on foraging communications.

Step 5: Calculate broadband source level of construction noise, 24-inch (60-centimeter) steel pile, impact driving:

- (a) 72 dB re 20 μ Pa @ 15m (3.15 kHz one-third octave [OTO] band level), [Illingworth & Rodkin 2012, Figure C394, p. C-184, source level at 15 meters, Leq, unweighted, 3.15 kHz OTO]

Step 6: Calculate propagation of broadband source level to 1 meter standard distance, assuming spherical spreading over water: **Source level @ 1m = 72 dB re 20 μ Pa @ 15m + 20·log₁₀(15m/1m) = 95.5 dB re 20 μ Pa @ 1m (3.15 kHz OTO band)**

Step 7: Convert (OTO) source level to spectrum level (//Hz)

- (a) Spectrum Level Conversion Factor (dB) = 10·log₁₀(broadband bandwidth (Hz)/ 1 Hz)
- (b) **Spectrum Level Conversion Factor (dB) = 10·log₁₀(730 Hz/1 Hz) = 28.6 dB**
Source level (spectrum level) = 95.5 dB – 28.6 dB = 66.9 dB re 20 μ Pa//Hz @ 1m (spectrum level at 3 kHz)

Step 8: Calculate maximum distance construction noise impinges on birds 30 meters apart by determining distance away from driven pile that noise attenuates to the maximum ambient noise threshold to not impinge on foraging communications:

Distance (m) = Inverse Log₁₀ ((Source spectrum level at 3 kHz, 1 meter – maximum ambient noise level)/20)

Distance (m) = Inverse Log₁₀ ((66.9 – 34.5)/20) = 42 meters

5.0 DEFINITIONS

Ambient sound. Background sound levels on a site; may include project-generated noise.

Broadband. Sound containing frequencies across a wide range, e.g., 20 Hz to 20 kHz.

Critical ratio. The ratio of a signal level to the spectrum level of a non-signal sound. Ambient (background) noise in the frequency range of the signal is most important in masking the signal.

Keer call. A vocalization of marbled murrelets used by foraging birds to communicate with foraging partners.

Masking. The increase in the detection threshold of a sound (signal) due to the presence of another sound (non-signal) in the same frequency range.

OTO. One-third octave frequency range. The frequency scale is logarithmic, and higher frequencies have higher bandwidths. For example, the one-third octave band centered at 315 Hz is approximately 73 Hz wide, whereas the 3,150 Hz one-third octave is nominally 730 Hz wide.

Recognition differential. A range of sound levels that allows the receiving individual to recognize and identify that there is meaningful content in the signal.

Source level. Sound energy, in decibels above a reference level, at a specified distance from the source of the sound.

Spectrum level. Sound energy at a particular frequency with 1.0 Hz bandwidth. The frequency of 3,150 Hz is a relevant frequency for birds because it is centered on the zone of maximum hearing sensitivity for many species.

//. Spectrum level notation; e.g., 5 dB//Hz signifies a spectrum sound level of 5 dB at a specified frequency such as 3 kHz.

6.0 LITERATURE CITED

- Acoustical Society of America. 1994. American National Standard Acoustical Terminology. ANSI (American National Standards Institute) S1.1-1994 (ASA 111-1994). Standards Secretariat, Acoustical Society of America, New York. Approved January 4, 1994.
- Barlett, M.L., and G.R. Wilson. 2002. Characteristics of small boat signatures. *The Journal of the Acoustical Society of America*. 112(5): 2221.
- Betke, K. 2006. Measurement of underwater noise emitted by an offshore wind turbine at Horns Rev. ITAP report 13/02/2006. 19 pp.
- Carlson, T.J., Woodruff, D.A., Johnson, G.E., Kohn, N.P., Plosky, G.R., Weiland, M.A., Southard, J.A., and Southard, J.L. 2005. Hydroacoustic measurements during pile driving at the Hood Canal Bridge, September through November 2004. Battelle Marine Sciences Laboratory, Sequim, WA.
- DEFRA - Department for Environment, Food and Rural Affairs. (2003). Preliminary investigation of the sensitivity of fish to sound generated by aggregate dredging and marine construction. Project AE0914 Final Report. Retrieved from <http://randd.defra.gov.uk/Default.aspx?Menu=Menu&Module=More&Location=None&Completed=0&ProjectID=9098> as accessed on 18 August 2014
- Galli, L., B. Hurlbutt, W. Jewett, W. Morton, S. Schuster, and Z. Van Hilsen. 2003. Boat Source-Level Noise in Haro Strait: Relevance to Orca Whales. Retrieved from <http://www2.coloradocollege.edu/dept/ev/Research/Faculty/OVALItems/FinalRptWeb/finalAll.html> as accessed on 18 August 2014
- Götz, T., G. Hastie, L. Hatch, O. Raustein, B.L. Southall, M. Tasker, and R. Thomsen. 2009. Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR Convention) Report: Overview of the impacts of anthropogenic underwater sound in the marine environment.
- HDR. 2012. Naval Base Kitsap at Bangor Test Pile Program Final Marine Mammal Monitoring Report, Bangor, Washington. Prepared by HDR. Prepared for Naval Facilities Engineering Northwest, Silverdale, WA. April 2012.
- Hildebrand, J.A. 2004. Sources of anthropogenic sound in the marine environment. Marine Mammal Commission and Scripps Institution of Oceanography, University of California San Diego, San Diego, CA. Background paper for the International Policy Workshop on Sound and Marine Mammals in London, England, September 28–30, 2004. <http://www.mmc.gov/sound/internationalwrkshp/pdf/hildebrand.pdf>.
- ICF Jones and Stokes, and Illingworth & Rodkin. 2012. Appendix I: Compendium of pile driving sound data. Technical guidance for assessment and mitigation of the hydroacoustic effects of pile driving on fish. Prepared by ICF Jones and Stokes, Sacramento, CA, and Illingworth & Rodkin, Inc., Petaluma, CA. Prepared for California Department of Transportation, Sacramento, CA. October 2012 update. http://www.dot.ca.gov/hq/env/bio/files/hydroacstc_compendium.pdf.

- Illingworth & Rodkin. 2001. Noise and Vibration Measurements Associated with the Pile Installation Demonstration Project for the San Francisco-Oakland Bay Bridge East Span, Chapter 4. Prepared by Illingworth & Rodkin, Petaluma, CA. Prepared for the California Department of Transportation, Sacramento, CA.
- Illingworth & Rodkin. 2012. Naval Base Kitsap at Bangor Test Pile Program Acoustic Monitoring Report. Prepared for Naval Base Kitsap, Bangor, WA. April 17, 2012.
- Illingworth & Rodkin. 2013. Naval Base Kitsap at Bangor Trident Support Facilities Explosives Handling Wharf (EHW-2) Project. Acoustic Monitoring Report. Bangor, WA. Prepared for Naval Base Kitsap at Bangor, WA. May 15, 2013.
- Kinsler, L.E., Frey, A.R., Coppens, A.B. and Sanders, J.V. 1999. *Fundamentals of Acoustics* (4th ed.). New York, NY: Wiley.
- Laughlin, J. 2005. Effects of pile driving on fish and wildlife. Washington State Department of Transportation. Presentation to the Summer Meeting/Conference of the Transportation Research Board ADC40 (A1F04) Noise & Vibration Committee, Seattle, Washington. July 20.
- Laughlin, J. 2010. Personal communication via email between Jim Laughlin and Rick Huey, biologist Washington State Ferries, to Jim Laughlin, WSDOT Air/Acoustics/Energy Technical Manager, regarding underwater vibratory sound levels from the Port Townsend Vibratory Test Pile project. November 15, 2010.
- Laughlin, J. 2014. Compendium of background sound levels for ferry terminals in Puget Sound (Final report). WSF Underwater Background Monitoring Project - Technical Report. Washington State Department of Transportation, Office of Air Quality and Noise, Seattle, WA. September 4, 2014. [Note: cover date says April 2014 but all subsequent pages have a footer indicating September 4, 2014].
http://www.wsdot.wa.gov/NR/rdonlyres/7CD4A4B6-99CF-4670-BD88-E82F96F4627B/0/WSF_SoundLevelReport.pdf.
- Longmuir, C., and T. Lively. 2001. Bubble curtain systems help protect the marine environment. *Pile Driver Magazine* (A publication of the Pile Driving Contractors Association). Summer 2001: 11–13, 16. <http://www.piledrivers.org/files/uploads/D325D9C4-A533-4832-942A-DFD5B78EB325.pdf>
- MacGillivray, A. O. and Chapman, N. R. 2005. Results from an acoustic modelling study of seismic airgun survey noise in Queen Charlotte Basin. University of Victoria School of Earth and Ocean Sciences.
- Matzner, S. and Jones, M. 2011. Measuring coastal boating noise to assess potential impacts on marine life. *Sea Technology*, 52(7), 41–44.
- McKenna, M. F., Ross, D., Wiggins, S. M. and Hildebrand, J. A. 2011. Underwater radiated noise from modern commercial ships. *Journal of the Acoustical Society of America*, 131(1), 92–103.

- Nedwell, J. R., Parvin, S. J., Edwards, B., Workman, R., Brooker, A. G. and Kynoch, J. E. 2007. Measurement and interpretation of underwater noise during construction and operation of offshore windfarms in UK water. Subacoustech Report No. 544R0738 to COWRIE Ltd.
- NMFS. 2013. Draft Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammals. Acoustic Threshold Levels for Onset of Permanent and Temporary Threshold Shifts. 23 December 2013.
http://www.nmfs.noaa.gov/pr/acoustics/draft_acoustic_guidance_2013.pdf
- Nowacek, D.P., L.H. Thorne, D.W. Johnston, and P.L. Tyack. 2007. Responses of cetaceans to anthropogenic noise. *Mammal Review*. 37(2): 81–115.
- Reine, K.J., Clarke, D., Dickerson, C. and Wikle, G. 2014. Characterization of Underwater Sounds Produced by Trailing Suction Hopper Dredges During Sand Mining and Pump-out Operations. ERDC – U.S. Army Corps of Engineers. ERDC/EL TR-14-3
- Richardson, W.J., G.R. Greene, Jr., C.I. Malme, and D.H. Thomson. 1995. *Marine mammals and noise*. San Diego, CA: Academic Press. 576 pp.
- SAIC (Science Applications International Corporation). 2012. Final Summary Report: Marbled Murrelet Hydroacoustic Science Panel II. Pages 19–22. Panel conducted March 28–30, 2012, attended by representatives of the U.S. Fish and Wildlife Service, U.S. Geological Survey, National Marine Fisheries Service, U.S. Navy, and other experts. Prepared by Bernice Tannenbaum, Science Applications International Corporation, Bothell, WA. Prepared for NAVFAC Northwest, Silverdale, WA. September 4, 2012.
- Sebastianutto, L., Picciulin, M., Costantini, M. and Ferrero, E. A. 2011. How boat noise affects an ecologically crucial behavior: the case of territoriality in *Gobius cruentatus* (Gobiidae). *Environmental Biology of Fishes*. 92(2): 207–215.
- Slater, M.C. 2009. Naval Base Kitsap, Bangor baseline underwater noise survey report. Prepared by Science Applications International Corporation, Bremerton, WA. Prepared for BAE Systems Applied Technologies, Inc., Rockville, MD. February 18, 2009.
- Southall, B.L., Bowles, A.E., Ellison, W.T., Finneran, J.J., Gentry, R.L., Greene, C.R. Jr., Kastak, D., Ketten, D.K., Miller, J.H., Nachtigall, P.E., Richardson, W.J., Thomas, J.A. and Tyack, P.L. 2007. Marine mammal noise exposure criteria: initial scientific recommendations. *Special Issue of Aquatic Mammals*. 33(4): 412–522.
- USFWS (U.S. Fish and Wildlife Service). 2013. Conducting masking analysis for marbled murrelets & pile driving projects. Presentation for WSDOT Biologists and Consultants by Emily Teachout. U.S. Fish and Wildlife Service, Washington Fish and Wildlife Office Transportation Branch, Lacey, WA. November 19, 2013.
- Veirs, V., and Veirs, S. 2005. One year of background underwater sound levels in Haro Strait, Puget Sound. *The Journal of the Acoustical Society of America*. 117(4): 2577–2578.
- Ward, W.D. 1997. Effects of high-intensity sound. In M. J. Crocker (Ed.), *Encyclopedia of Acoustics* (pp. 1497–1507). New York, NY: Wiley.

WSDOT (Washington State Department of Transportation). 2005a. Underwater sound levels associated with pile driving at the Bainbridge Island Ferry Terminal preservation project. November 2005. <http://www.wsdot.wa.gov/NR/rdonlyres/8AD90843-1DF0-48B7-A398-2A2BFD851CF8/0/BainbridgeFerryTerminal.pdf>

WSDOT 2005b. Underwater sound levels associated with restoration of the Friday Harbor Ferry Terminal. May 2005. <http://www.wsdot.wa.gov/NR/rdonlyres/BCFD911C-990C-4C38-BA09-AA05145DCDB2/0/FridayHarborFerryTerminal.pdf>

WSDOT. 2007a. Underwater sound levels associated with driving steel and concrete piles near the Mukilteo Ferry Terminal. Washington State Department of Transportation. WSF Mukilteo Test Pile Project. March 2007.
<http://www.wsdot.wa.gov/NR/rdonlyres/64500C4E-3472-4D03-84DF-9F2C787A28EC/0/MukilteoFerryTermTestPileRptWSDOT.pdf>

WSDOT 2007b. Underwater sound levels associated with pile driving during the Anacortes Ferry Terminal dolphin replacement project. April 2007.
<http://www.wsdot.wa.gov/NR/rdonlyres/5AD837F4-0570-4631-979B-AC304DCC5FA0/0/AnacortesFerryTerminal.pdf>

WSDOT. 2010a. Average noise reductions using different minimization strategies for WSDOT impact pile driving operations. Memorandum from Jim Laughlin to Sharon Rainsberry. Washington State Department of Transportation, Olympia, WA. July 20, 2010.

WSDOT. 2010b. Port Townsend Test Pile Project. Underwater Noise Monitoring Draft Final Report. November 10, 2010. <http://www.wsdot.wa.gov/NR/rdonlyres/A3B9B492-9490-4526-88C5-2B09A3A6ACB5/0/PortTownsendTestPileRpt.pdf>

WSDOT. 2010c. REVISED Friday Harbor Vibratory Pile Monitoring. Technical Memorandum prepared by Jim Laughlin for John Callahan and Rick Huey. Washington State Department of Transportation, Office of Air Quality and Noise, Seattle, Washington. March 15, 2010.

WSDOT. 2011. Edmonds Ferry Terminal – Vibratory pile monitoring Technical Memorandum prepared by Jim Laughlin for John Callahan and Rick Huey. Washington State Department of Transportation, Office of Air Quality and Noise, Seattle, Washington. October 20, 2011.

WSDOT. 2012. Underwater vibratory sound levels from a steel and plastic on steel pile installation at the Anacortes Ferry Terminal. March 2012.

WSDOT. 2013. Biological Assessment Preparation for Transportation Projects - Advanced Training Manual. Version 2013. Washington State Department of Transportation, Olympia, WA. February 2013.
<http://www.wsdot.wa.gov/Environment/Biology/BA/BAGuidance.htm#Manual>.

This page is intentionally blank.

APPENDIX E

AIR QUALITY EMISSIONS CALCULATIONS

TABLE OF CONTENTS

Table 1.	Emission Source Data for Construction of LWI - Pile-Supported Pier.....	E-1
Table 2.	Emission Source Data for Construction of LWI - PSB Modifications.....	E-2
Table 3.	Emission Source Data for Construction of SPE - Short Pier.....	E-3
Table 4.	Emission Source Data for Construction of SPE - Long Pier.....	E-4
Table 5.	Emission Factors for Construction of LWI	E-5
Table 6.	Total Emissions for Construction of LWI - Pile-Supported Pier	E-6
Table 7.	Total Emissions for Construction of LWI - PSB Modifications	E-7
Table 8.	Total Emissions for Construction of SPE - Short Pier	E-8
Table 9.	Total Emissions for Construction of SPE - Long Pier	E-9
Table 10.	Air Emissions for LWI - Pile-Supported Pier	E-10
Table 11.	Air Emissions for LWI - PSB Modifications	E-10
Table 12.	Air Emissions for SPE - Short Pier	E-10
Table 13.	Air Emissions for SPE - Long Pier	E-10
Table 14.	Construction Worker Activity.....	E-11
Table 15.	Emission Factors for Construction Commuter Vehicles	E-11
Table 16.	Air Emissions for Construction Commuter Vehicles	E-11
Table 17.	Operational Emissions for SPE - Support Buildings (tons per year)	E-12
Table 18.	Comparison of Air Emissions Total Impacts for LWI and SPE Project Alternatives	E-12
Table 19.	Comparison of Construction-Related Air Emissions for LWI Project Alternatives	E-12
Table 20.	Comparison of Construction-Related Air Emissions for SPE Project Alternatives	E-12

This page is intentionally blank.

Table 1. Emission Source Data for Construction of LW - Pile-Supported Pier

Construction Activity/Equipment Type	Max HP Rating	Ave. Daily Load Factor	Number Active	Estimated Avg HP	Hours/ Day	Daily Hp-Hrs	Work Days	Total Hp-Hrs
Construction (1) (10)								
Crane Hoist	564	0.25	1	141	4.0	564	80.0	45,120
Generator - Pile Hammer	190	0.60	1	114	8.0	912	80.0	72,960
Tugboat	1,200	0.25	1	300	1.0	300	50.0	15,000
Barge Equipment	195	0.50	1	98	12.0	1,170	50.0	58,500
Tugboat - Material Deliveries (2) (3)	1,200	0.50	1	600	9.7	5,797	16.0	92,754
Backhoe	160	0.50	1	80	4.0	320	8.0	2,560
Bulldozer - D6	165	0.50	1	83	8.0	660	12.0	7,920
Compactive Roller (4)	165	0.50	1	83	8.0	660	8.0	5,280
Fugitive Dust (5)	NA	NA	1	NA	NA	NA	12.0	6
Grader	180	0.50	1	90	8.0	720	8.0	5,760
Haul Truck - Soil (6) (7)	NA	NA	34	NA	20.0	680	95.0	64,600
Other Construction Truck Traffic (6) (8)	NA	NA	20	NA	8.0	160	540.0	86,400
Other Construction Traffic (6) (8)	NA	NA	20	NA	30.0	600	540.0	324,000
Loader	215	0.50	1	108	8.0	860	8.0	6,880
Paving Machine	200	0.50	1	100	8.0	800	8.0	6,400
Water Truck - 5,000 Gallons	175	0.40	1	70	6.0	420	12.0	5,040
Phase 2 Grate/Mesh Installation (9)								
Tugboat	1,200	0.25	1	300	1	300	260.0	78,000
Barge Equipment	195	0.50	1	98	12	1,170	260.0	304,200
Derrick Barge Crane Hoist	564	0.25	1	141	4	564	260.0	146,640

Notes: (1) Pile driving equipment usage estimates based on 80 days, 256 piles.

(2) Hours per day = Hours per trip, Daily HP Hours = HP hours per trip, and Work Days = # of trips

(3) Assuming that the materials are 50 miles away and the tug travels at a speed of 9 knots

(4) Number Active is acres to be paved.

(5) Number Active = acres disturbed per day, Total Hp-Hrs = total acre-days.

(6) Number Active = miles/roundtrip, Hours/Day = daily truck trips, Daily Hp-Hrs = daily miles, and Total Hp-Hrs = total miles.

(7) Assuming that concrete comes from Bremerton, WA, a round trip distance of 34 miles.

(8) Average round trip for construction related truck or vehicle trip estimated at 20 miles.

(9) Phase 2 will be the remaining days, 260, of the over-water construction period.

(10) Phase 1 construction activity data based on an acreage comparison of POLA Berths 136-147 Container Terminal Project, FEIS/FEIR December 2007 and the SCAQMD construction survey.

Table 2. Emission Source Data for Construction of LWI - PSB Modifications

Construction Activity/Equipment Type	Max HP Rating	Ave. Daily Load Factor	Number Active	Estimated Avg HP	Hours/ Day	Daily Hp-Hrs	Work Days	Total Hp-Hrs
Construction (1) (9)								
Crane Hoist	564	0.25	1	141	4.0	564	30.0	16,920
Generator - Pile Hammer	190	0.60	1	114	8.0	912	30.0	27,360
Tugboat	1,200	0.25	1	300	1.0	300	30.0	9,000
Barge Equipment	195	0.50	1	98	12.0	1,170	30.0	35,100
Tugboat - Material Deliveries (2) (3)	1,200	0.50	1	600	9.7	5,797	3.0	17,391
Backhoe	160	0.50	1	80	4.0	320	8.0	2,560
Bulldozer - D6	165	0.50	1	83	8.0	660	12.0	7,920
Compactive Roller (4)	165	0.50	1	83	8.0	660	8.0	5,280
Fugitive Dust (5)	NA	NA	0.5	NA	NA	NA	12.0	6
Grader	180	0.50	1	90	8.0	720	8.0	5,760
Haul Truck - Soil (6) (7)	NA	NA	34	NA	20.0	680	95.0	64,600
Other Construction Truck Traffic (6) (8)	NA	NA	20	NA	8.0	160	540.0	86,400
Other Construction Traffic (6) (8)	NA	NA	20	NA	30.0	600	540.0	324,000
Loader	215	0.50	1	108	8.0	860	8.0	6,880
Paving Machine	200	0.50	1	100	8.0	800	8.0	6,400
Semi Truck (6) (8)	NA	NA	93	NA	2.0	186	8.0	1,488
Water Truck - 5,000 Gallons	175	0.40	1	70	6.0	420	12.0	5,040

Notes: (1) Pile driving equipment usage estimates based on 30 days, 34 piles.

(2) Hours per day = Hours per trip, Daily HP Hours = HP hours per trip, and Work Days = # of trips

(3) Assuming that the materials are 50 miles away and the tug travels at a speed of 9 knots

(4) Number Active is acres to be paved.

(5) Number Active = acres disturbed per day, Total Hp-Hrs = total acre-days.

(6) Number Active = miles/roundtrip, Hours/Day = daily truck trips, Daily Hp-Hrs = daily miles, and Total Hp-Hrs = total miles.

(7) Assuming that concrete comes from Bremerton, WA, a round trip distance of 34 miles.

(8) Average round trip for construction related truck or vehicle trip estimated at 20 miles.

(9) Data for construction activity taking place on land based on an acreage comparison of POLA Berths 136-147 Container

Terminal Project, FEIS/FEIR December 2007 and the SCAQMD construction survey.

Table 3. Emission Source Data for Construction of SPE - Short Pier

Construction Activity/Equipment Type	Max HP Rating	Ave. Daily Load Factor	Number Active	Estimated Avg HP	Hours/ Day	Daily Hp-Hrs	Work Days	Total Hp-Hrs
Over Water Construction (1)								
Crane Hoist	564	0.25	1	141	4.0	564	161.0	90,804
Generator - Pile Hammer	190	0.60	1	114	8.0	912	161.0	146,832
Tugboat	1,200	0.25	1	300	1.0	300	161.0	48,300
Barge Equipment	195	0.50	1	98	12.0	1,170	161.0	188,370
Tugboat - Material Deliveries (2) (3)	1,200	0.50	1	600	9.7	5,797	144.0	834,783
Pier Services and Compressor Bldg (7)								
Air Compressor - 100 CFM	50	0.60	1	30	6.0	180	3.6	648
Concrete/Industrial Saw	84	0.73	1	61	6.0	368	3.6	1,325
Crane	190	0.30	1	57	6.0	342	3.6	1,231
Forklift	94	0.48	1	45	6.0	268	3.6	964
Generator	45	0.60	1	27	8.0	216	3.6	778
Fugitive Dust (6)	NA	NA	0.05	NA	8.0	NA	0.9	1.0
Waterfront Ship Support Building (7)								
Air Compressor - 100 CFM	50	0.60	1	30	6.0	180	90.0	16,200
Concrete/Industrial Saw	84	0.73	1	61	6.0	368	90.0	33,113
Crane	190	0.30	1	57	6.0	342	90.0	30,780
Forklift	94	0.48	1	45	6.0	268	90.0	24,111
Generator	45	0.60	1	27	8.0	216	90.0	19,440
Fugitive Dust (6)	NA	NA	1.1	NA	8.0	NA	21.8	25
Parking Lot (7)								
Paving Machine	200	0.50	1	100	8.0	800	4.0	3,200
Water Truck - 5,000 Gallons	175	0.40	1	70	8.0	560	5.7	3,200
Compactive Roller	165	0.50	2	165	8.0	1,320	2.3	3,093
Scraper	195	0.50	2	195	8.0	1,560	4.0	6,240
Grader	180	0.50	1	90	8.0	720	5.0	3,600
Loader	215	0.50	1	108	8.0	860	5.0	4,300
Backhoe	160	0.50	1	80	8.0	640	4.0	2,560
Bulldozer - D6	165	0.50	1	83	8.0	660	4.0	2,640
Fugitive Dust (6)	NA	NA	3	NA	8.0	NA	5.7	17
Construction Truck and Vehicle Trips								
Construction Truck Traffic (4) (5)	NA	NA	20	NA	18.0	360	400	144,000
Construction Vehicle Traffic (4) (5)	NA	NA	20	NA	70.0	1,400	400	560,000

Notes: (1) Pile driving equipment usage estimates based on 161 days, 385 piles.

(2) Hours per day = Hours per trip, Daily HP Hours = HP hours per trip, and Work Days = # of trips

(3) Assuming that the materials are 50 miles away and the tug travels at a speed of 9 knots

(4) Number Active = miles/roundtrip, Hours/Day = daily truck trips, Daily Hp-Hrs = daily miles, and Total Hp-Hrs = total miles.

(5) Average round trip for construction related truck or vehicle trip estimated at 20 miles.

(6) Number Active = acres disturbed per day, Total Hp-Hrs = total acre-days.

(7) Construction is based on a acreage comparison of POLA Berths 136-147 Container Terminal Project, FEIS/FEIR

December 2007, the SCAQMD construction survey and data provided by the US Navy in a 3/20/2013 email.

Table 4. Emission Source Data for Construction of SPE - Long Pier

Construction Activity/Equipment Type	Max HP Rating	Ave. Daily Load Factor	Number Active	Estimated Avg HP	Hours/ Day	Daily Hp-Hrs	Work Days	Total Hp-Hrs
Over Water Construction (1)								
Crane Hoist	564	0.25	1	141	4.0	564	205.0	115,620
Generator - Pile Hammer	190	0.60	1	114	8.0	912	205.0	186,960
Tugboat	1,200	0.25	1	300	1.0	300	205.0	61,500
Barge Equipment	195	0.50	1	98	12.0	1,170	205.0	239,850
Tugboat - Material Deliveries (2) (3)	1,200	0.50	1	600	9.7	5,797	252.0	1,460,870
Pier Services and Compressor Bldg (7)								
Air Compressor - 100 CFM	50	0.60	1	30	6.0	180	3.6	648
Concrete/Industrial Saw	84	0.73	1	61	6.0	368	3.6	1,325
Crane	190	0.30	1	57	6.0	342	3.6	1,231
Forklift	94	0.48	1	45	6.0	268	3.6	964
Generator	45	0.60	1	27	8.0	216	400.0	86,400
Fugitive Dust (6)	NA	NA	0.05	NA	8.0	NA	4.0	0
Waterfront Ship Support Building (7)								
Air Compressor - 100 CFM	50	0.60	1	30	6.0	180	90.0	16,200
Concrete/Industrial Saw	84	0.73	1	61	6.0	368	90.0	33,113
Crane	190	0.30	1	57	6.0	342	90.0	30,780
Forklift	94	0.48	1	45	6.0	268	90.0	24,111
Generator	45	0.60	1	27	8.0	216	90.0	19,440
Fugitive Dust (6)	NA	NA	1	NA	8.0	NA	21.8	25
Parking Lot (7)								
Paving Machine	200	0.50	1	100	8.0	800	4.0	3,200
Water Truck - 5,000 Gallons	175	0.40	1	70	8.0	560	5.7	3,200
Compactive Roller	165	0.50	2	165	8.0	1,320	2.3	3,093
Scraper	195	0.50	2	195	8.0	1,560	4.0	6,240
Grader	180	0.50	1	90	8.0	720	5.0	3,600
Loader	215	0.50	1	108	8.0	860	5.0	4,300
Backhoe	160	0.50	1	80	8.0	640	4.0	2,560
Bulldozer - D6	165	0.50	1	83	8.0	660	4.0	2,640
Fugitive Dust (6)	NA	NA	3	NA	8.0	NA	5.7	17
Construction Truck and Vehicle Trips								
Construction Truck Traffic (4) (5)	NA	NA	20	NA	18.0	360	400.0	144,000
Construction Vehicle Traffic (4) (5)	NA	NA	20	NA	70.0	1,400	400.0	560,000

Notes: (1) Pile driving equipment usage estimates based on 205 days, 660 piles.

(2) Hours per day = Hours per trip, Daily HP Hours = HP hours per trip, and Work Days = # of trips

(3) Assuming that the materials are 50 miles away and the tug travels at a speed of 9 knots

(4) Number Active = miles/roundtrip, Hours/Day = daily truck trips, Daily Hp-Hrs = daily miles, and Total Hp-Hrs = total miles.

(5) Average round trip for construction related truck or vehicle trip estimated at 20 miles.

(6) Number Active = acres disturbed per day, Total Hp-Hrs = total acre-days.

(7) Construction is based on a acreage comparison of POLA Berths 136-147 Container Terminal Project, FEIS/FEIR

December 2007, the SCAQMD construction survey and data provided by the US Navy in a 3/20/2013 email.

Table 5. Emission Factors for Construction of LW

Project Year/Source Type	Fuel Type	Emission Factors									Units	References
		VOC	CO	NO _x	SO ₂	PM ₁₀	PM _{2.5}	N ₂ O	CH ₄	CO ₂		
Year 2014												
Off-Road Equipment - 25-39 Hp	D	0.38	1.65	4.20	0.76	0.66	0.64	0.09	0.01	609.7	g/hp-hr	(1), (6)
Off-Road Equipment - 40-49 Hp	D	0.36	1.58	4.14	0.76	0.67	0.65	0.09	0.01	611.0	g/hp-hr	(1), (6)
Off-Road Equipment - 50-74 Hp	D	0.43	2.80	4.07	0.79	0.65	0.63	0.09	0.01	607.5	g/hp-hr	(1), (6)
Off-Road Equipment - 75-99 Hp	D	0.44	3.02	3.47	0.77	0.78	0.75	0.09	0.01	608.1	g/hp-hr	(1), (6)
Off-Road Equipment - 100-174 Hp	D	0.32	1.26	3.00	0.69	0.59	0.57	0.09	0.01	546.5	g/hp-hr	(1), (6)
Off-Road Equipment - 175-299 Hp	D	0.24	0.81	2.56	0.66	0.55	0.53	0.09	0.01	538.7	g/hp-hr	(1), (6)
Off-Road Equipment - 300-599 Hp	D	0.22	1.19	3.13	0.67	0.49	0.47	0.08	0.01	534.6	g/hp-hr	(1), (6)
Off-Road Equipment - 600-749 Hp	D	0.21	1.50	3.12	0.67	0.49	0.48	0.08	0.01	534.3	g/hp-hr	(1), (6)
Off-Road Equipment - 750-999 Hp	D	0.32	1.15	4.48	0.67	0.53	0.51	0.08	0.01	534.0	g/hp-hr	(1), (6)
Off-Road Equipment - 1000-1199 Hp	D	0.32	1.09	4.39	0.67	0.53	0.52	0.08	0.01	534.2	g/hp-hr	(1), (6)
Off-Road Equipment - 1200-1999 Hp	D	0.33	1.24	4.45	0.67	0.54	0.53	0.00	0.01	534.8	g/hp-hr	(1), (6)
On-Road Truck - 10 mph		0.28	0.92	3.87	0.65	0.56	0.54	0.00	0.01	535.7	g/mi	(2)
On-Road Truck - 25 mph		0.47	1.43	4.34	0.01	0.14	0.11	0.00	0.01	19.5	g/mi	(2)
On-Road Truck - 55 mph		0.34	0.94	3.87	0.01	0.14	0.11	0.00	0.01	19.5	g/mi	(2)
On-Road Trucks - Composite		0.36	1.03	3.96	0.05	0.16	0.13	0.00	0.01	45.3	g/mi	(3)
On-Road Vehicles - Composite		1.65	14.06	8.47	0.01	0.44	0.44	0.02	0.07	1,189.22	g/mi	(2)
All Years												
Tugboat	D	0.53	1.10	13.20	0.81	0.72	0.67	0.08	0.06	146.9	g/hp-hr	(4)
Small Harbor Craft	D	0.16	1.27	7.46	0.47	0.30	0.28	0.09	0.01	668.2	g/hp-hr	(1)
Fugitive Dust	---	---	---	---	27.50	13.45	---	---	---	lbs/acre-day		(5)

Notes: (1) Composite emission factors in [g/bhp-hr] developed from the USEPA NONROAD emissions model CY2014 assume two years before construction.

USEPA. 2009. NONROAD Model Core Model ver. 2008a, posted July 6, 2009. <http://www.epa.gov/otaq/nonrdmdl.htm>.

(2) CY2014 HHDV On-road emissions factors in [g/mi] developed from the USEPA MOVES emissions model (<http://www.epa.gov/otaq/models/moves-docum.htm>). [g/hr or g/mi]

(3) Composite factors based on a round trip of 75% at 55 mph, 20% at 25 mph, and 5% at 5 mph. Units in grams/mile.

(4) Entec UK Ltd. 2002. European Commission Quantification of emissions from ships associated with ship movements between ports in the European Community. Final Report. Northwich, Cheshire, UK. July 2002.

(5) Units in lbs/acre-day: USEPA. 1995. Heavy Construction Operations (Section 13.2.3). In Compilation of air pollutant emission factors. Washington, DC: U. S. Environmental Protection Agency. <http://www.epa.gov/ttn/chief/ap42/ch13/final/c13s02-3.pdf>.

(6) N₂O and CH₄ EFs are from the GHG Emission Factors from The Climate Registry GHG Reporting Protocol (www.theclimateregistry.org).

Table 6. Total Emissions for Construction of LM - Pile-Supported Pier

Construction Activity/Equipment Type	Tons								
	VOC	CO	NO _x	SO ₂	PM ₁₀	PM _{2.5}	N ₂ O	CH ₄	CO ₂
Construction									
Crane Hoist	0.01	0.06	0.16	0.03	0.02	0.02	0.00	0.00	26.6
Generator - Pile Hammer	0.02	0.07	0.21	0.05	0.04	0.04	0.01	0.00	43.3
Tugboat	0.01	0.02	0.22	0.01	0.01	0.01	0.00	0.00	2.4
Barge Equipment	0.02	0.05	0.16	0.04	0.04	0.03	0.01	0.00	34.7
Tugboat - Pile Deliveries	0.05	0.11	1.35	0.08	0.07	0.07	0.01	0.01	15.0
Backhoe	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.0
Bulldozer - D6	0.00	0.01	0.03	0.01	0.01	0.00	0.00	0.00	0.0
Compactive Roller	0.00	0.01	0.02	0.00	0.00	0.00	0.00	0.00	0.0
Fugitive Dust	-	-	-	-	0.08	0.04	-	-	-
Grader	0.00	0.01	0.02	0.00	0.00	0.00	0.00	0.00	3.4
Haul Truck - Soil	0.03	0.07	0.28	0.00	0.01	0.01	0.00	0.00	3.3
Other Construction Truck Traffic	0.03	0.10	0.38	0.00	0.02	0.01	0.00	0.00	4.5
Other Construction Traffic	0.59	5.02	3.03	0.01	0.16	0.16	0.01	0.03	425.5
Loader	0.00	0.01	0.02	0.00	0.00	0.00	0.00	0.00	4.1
Paving Machine	0.00	0.01	0.02	0.00	0.00	0.00	0.00	0.00	3.8
Water Truck	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	3.0
Subtotal	0.77	5.55	5.91	0.27	0.48	0.42	0.04	0.03	447.7
Phase 2 - Grate Installation									
Tugboat	0.05	0.09	1.13	0.07	0.06	0.06	0.01	0.00	12.63
Barge Equipment	0.08	0.27	0.86	0.22	0.18	0.18	0.03	0.00	180.65
Derrick Barge Crane Hoist	0.03	0.19	0.51	0.11	0.08	0.08	0.01	0.00	86.42
Subtotal	0.16	0.56	2.50	0.40	0.33	0.31	0.05	0.01	279.69

Table 7. Total Emissions for Construction of LM - PSB Modifications

Construction Activity/Equipment Type	Tons								
	VOC	CO	NO _x	SO ₂	PM ₁₀	PM _{2.5}	N ₂ O	CH ₄	CO ₂
Construction									
Crane Hoist	0.00	0.02	0.06	0.01	0.01	0.01	0.00	0.00	10.0
Generator - Pile Hammer	0.01	0.02	0.08	0.02	0.02	0.02	0.00	0.00	16.2
Tugboat	0.01	0.01	0.13	0.01	0.01	0.01	0.00	0.00	1.5
Barge Equipment	0.01	0.03	0.10	0.03	0.02	0.02	0.00	0.00	20.8
Tugboat - Pile Deliveries	0.01	0.02	0.25	0.02	0.01	0.01	0.00	0.00	2.8
Backhoe	0.00	0.00	0.01	0.00	0.00	0.00	0.01	0.00	1.5
Bulldozer - D6	0.00	0.01	0.03	0.01	0.01	0.00	0.00	0.00	4.8
Compactive Roller	0.00	0.01	0.02	0.00	0.00	0.00	0.00	0.00	3.2
Fugitive Dust	-	-	-	-	0.08	0.04	-	-	-
Grader	0.00	0.01	0.02	0.00	0.00	0.00	0.00	0.00	3.4
Haul Truck - Soil	0.03	0.07	0.28	0.00	0.01	0.01	0.00	0.00	3.3
Other Construction Truck Traffic	0.03	0.10	0.38	0.00	0.02	0.01	0.00	0.00	4.5
Other Construction Traffic	0.59	5.02	3.03	0.01	0.16	0.16	0.01	0.03	425.5
Loader	0.00	0.01	0.02	0.00	0.00	0.00	0.00	0.00	4.1
Paving Machine	0.00	0.01	0.02	0.00	0.00	0.00	0.00	0.00	3.8
Semi Truck	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.1
Water Truck	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	3.0
Subtotal	0.66	5.24	3.82	0.04	0.29	0.24	0.02	0.03	457.2

Table 8. Total Emissions for Construction of SPE - Short Pier

Construction Activity/Equipment Type	Tons								
	VOC	CO	NO _x	SO ₂	PM ₁₀	PM _{2.5}	N ₂ O	CH ₄	CO ₂
Over Water Construction									
Derrick Barge Crane Hoist	0.02	0.12	0.31	0.07	0.05	0.05	0.01	0.00	53.5
Generator - Pile Hammer	0.04	0.13	0.41	0.11	0.09	0.09	0.02	0.00	87.2
Tugboat	0.02	0.07	0.24	0.04	0.03	0.03	0.00	0.00	28.5
Barge Equipment	0.05	0.17	0.53	0.14	0.11	0.11	0.02	0.00	111.9
Tugboat - Pile Deliveries	0.48	1.01	12.15	0.75	0.66	0.62	0.08	0.05	135.1
Subtotal	0.61	1.50	13.64	1.09	0.94	0.89	0.12	0.06	416.2
Pier Services and Compressor Bldg									
Air Compressor - 100 CFM	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.4
Concrete/Industrial Saw	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.9
Crane	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.7
Forklift	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.6
Generator	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.5
Fugitive Dust	-	-	-	-	0.00	0.00	-	-	-
Subtotal	0.00	0.01	0.02	0.00	0.00	0.00	0.00	0.00	3.2
Waterfront Ship Support Building									
Air Compressor - 100 CFM	0.01	0.05	0.07	0.01	0.01	0.01	0.00	0.00	10.8
Concrete/Industrial Saw	0.02	0.11	0.13	0.03	0.03	0.03	0.00	0.00	22.2
Crane	0.01	0.03	0.09	0.02	0.02	0.02	0.00	0.00	18.3
Forklift	0.01	0.08	0.09	0.02	0.02	0.02	0.00	0.00	16.2
Generator	0.01	0.03	0.09	0.02	0.01	0.01	0.00	0.00	13.1
Fugitive Dust	-	-	-	-	0.01	0.00	-	-	-
Subtotal	0.05	0.30	0.47	0.10	0.10	0.09	0.01	0.00	80.6
Parking Lot									
Paving Machine	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	1.9
Water Truck - 5,000 Gallons	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	1.9
Compactive Roller	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	1.9
Scraper	0.00	0.01	0.02	0.00	0.00	0.00	0.00	0.00	3.7
Grader	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	2.1
Loader	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	2.6
Backhoe	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	1.5
Bulldozer - D6	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	1.6
Fugitive Dust	-	-	-	-	0.00	0.00	-	-	-
Subtotal	0.01	0.03	0.09	0.02	0.02	0.02	0.00	0.00	17.2
Construction Truck and Vehicle Trips									
Construction Truck Traffic	0.06	0.16	0.63	0.01	0.03	0.02	0.00	0.00	7.54
Construction Vehicle Traffic	1.02	8.68	5.24	0.01	0.27	0.27	0.01	0.04	735.47
Subtotal	1.08	8.84	5.87	0.02	0.30	0.29	0.01	0.04	743.02

Table 9. Total Emissions for Construction of SPE - Long Pier

Construction Activity/Equipment Type	Tons								
	VOC	CO	NO _x	SO ₂	PM ₁₀	PM _{2.5}	N ₂ O	CH ₄	CO ₂
Over Water Construction									
Derrick Barge Crane Hoist	0.03	0.15	0.40	0.09	0.06	0.06	0.01	0.00	68.1
Generator - Pile Hammer	0.05	0.17	0.53	0.14	0.11	0.11	0.02	0.00	111.0
Tugboat	0.02	0.08	0.30	0.05	0.04	0.04	0.00	0.00	36.3
Barge Equipment	0.06	0.22	0.68	0.17	0.15	0.14	0.02	0.00	142.4
Tugboat - Pile Deliveries	0.85	1.77	21.26	1.30	1.16	1.09	0.13	0.09	236.5
Subtotal	1.01	2.39	23.16	1.74	1.52	1.43	0.19	0.10	594.3
Pier Services and Compressor Bldg									
Air Compressor - 100 CFM	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.4
Concrete/Industrial Saw	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.9
Crane	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.7
Forklift	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.6
Generator	0.03	0.15	0.39	0.07	0.06	0.06	0.01	0.00	58.2
Fugitive Dust	-	-	-	-	0.00	0.00	-	-	-
Subtotal	0.04	0.16	0.41	0.08	0.07	0.07	0.01	0.00	60.9
Waterfront Ship Support Building									
Air Compressor - 100 CFM	0.01	0.05	0.07	0.01	0.01	0.01	0.00	0.00	10.8
Concrete/Industrial Saw	0.02	0.11	0.13	0.03	0.03	0.03	0.00	0.00	22.2
Crane	0.01	0.03	0.09	0.02	0.02	0.02	0.00	0.00	18.3
Forklift	0.01	0.08	0.09	0.02	0.02	0.02	0.00	0.00	16.2
Generator	0.01	0.03	0.09	0.02	0.01	0.01	0.00	0.00	13.1
Fugitive Dust	-	-	-	-	0.01	0.00	-	-	-
Subtotal	0.05	0.30	0.47	0.10	0.10	0.09	0.01	0.00	80.6
Parking Lot									
Paving Machine	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	1.9
Water Truck - 5,000 Gallons	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	1.9
Compactive Roller	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	1.9
Scraper	0.00	0.01	0.02	0.00	0.00	0.00	0.00	0.00	3.7
Grader	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	2.1
Loader	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	2.6
Backhoe	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	1.5
Bulldozer - D6	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	1.6
Fugitive Dust	-	-	-	-	0.00	0.00	-	-	-
Subtotal	0.01	0.03	0.09	0.02	0.02	0.02	0.00	0.00	17.2
Construction Truck and Vehicle Trips									
Construction Truck Traffic	0.06	0.16	0.63	0.01	0.03	0.02	0.00	0.00	7.54
Construction Vehicle Traffic	1.02	8.68	5.24	0.01	0.27	0.27	0.01	0.04	735.47
Subtotal	1.08	8.84	5.87	0.02	0.30	0.29	0.01	0.04	743.02

Table 10. Air Emissions for LW - Pile-Supported Pier

Construction Activity	Tons									
	VOC	CO	NO _x	SO ₂	PM ₁₀	PM _{2.5}	N ₂ O	CH ₄	CO ₂	CO _{2e}
Construction Activity	0.77	5.55	5.91	0.27	0.48	0.42	0.03	0.03	406.1	417.6
Phase 2 - Grate/Mesh	0.16	0.56	2.50	0.40	0.33	0.31	0.05	0.01	253.7	268.5
Commuters	1.96	16.73	10.08	0.01	0.52	0.01	0.02	0.08	1,284.3	1,291.5
Total	2.89	22.84	18.49	0.68	1.33	0.75	0.10	0.11	1,944.2	1,977.5

N₂O, CH₄, CO₂, and CO_{2e} are in Metric Tons

Table 11. Air Emissions for LW - PSB Modifications

Construction Activity	Tons									
	VOC	CO	NO _x	SO ₂	PM ₁₀	PM _{2.5}	N ₂ O	CH ₄	CO ₂	CO _{2e}
Construction Activity	0.66	5.24	3.82	0.04	0.29	0.24	0.02	0.02	414.8	420.7
Commuters	1.96	16.73	10.08	0.01	0.52	0.01	0.02	0.08	1,284.3	1,291.5
Total	2.63	21.97	13.90	0.06	0.81	0.26	0.04	0.10	1,699.1	1,712.2

N₂O, CH₄, CO₂, and CO_{2e} are in Metric Tons

Table 12. Air Emissions for SPE - Short Pier

Construction Activity	Tons									
	VOC	CO	NO _x	SO ₂	PM ₁₀	PM _{2.5}	N ₂ O	CH ₄	CO ₂	CO _{2e}
Over Water Construction	0.61	1.50	13.64	1.09	0.94	0.89	0.11	0.05	377.5	412.0
Pier Services and Compressor Bldg.	0.00	0.01	0.02	0.00	0.00	0.00	0.00	0.00	2.9	3.1
Waterfront Ship Support Building	0.05	0.30	0.47	0.10	0.10	0.09	0.01	0.00	73.1	76.7
Parking Lot	0.01	0.03	0.09	0.02	0.02	0.02	0.00	0.00	15.6	16.4
Bldg. Operations	0.07	0.37	0.07	-	-	-	-	-	-	-
Construction Truck and Vehicle Trips	1.08	8.84	5.87	0.02	0.30	0.29	0.01	0.04	743.02	747.4
Commuters	1.02	8.68	5.23	0.01	0.27	0.01	0.01	0.04	666.0	669.7
Total (Construction)	2.77	19.36	25.31	1.24	1.63	1.31	0.14	0.14	1,878.13	1,925.31
Total	2.84	19.74	25.38	1.24	1.63	1.31	0.14	0.14	1,878.13	1,925.31

N₂O, CH₄, CO₂, and CO_{2e} are in Metric Tons

Table 13. Air Emissions for SPE - Long Pier

Construction Activity	Tons									
	VOC	CO	NO _x	SO ₂	PM ₁₀	PM _{2.5}	N ₂ O	CH ₄	CO ₂	CO _{2e}
Over Water Construction	1.01	2.39	23.16	1.74	1.52	1.43	0.17	0.09	539.2	593.6
Pier Services and Compressor Bldg.	0.04	0.16	0.41	0.08	0.07	0.07	0.06	0.01	0.0	18.5
Waterfront Ship Support Building	0.05	0.30	0.47	0.10	0.09	0.10	0.08	0.01	0.0	26.5
Parking Lot	0.01	0.03	0.09	0.02	0.02	0.02	0.02	0.00	0.0	5.1
Bldg. Operations	0.07	0.37	0.07	-	-	-	-	-	-	-
Construction Truck and Vehicle Trips	1.08	8.84	5.87	0.02	0.30	0.29	0.01	0.04	743.02	747.4
Commuters	1.02	8.68	5.23	0.01	0.27	0.01	0.01	0.04	666.0	669.7
Total (Construction)	3.20	20.40	35.22	1.97	2.26	1.92	0.35	0.19	1,948.14	2,060.85
Total	3.27	20.78	35.29	1.97	2.26	1.92	0.35	0.19	1,948.14	2,060.85

N₂O, CH₄, CO₂, and CO_{2e} are in Metric Tons

Table 14. Construction Worker Activity

LWI - Pile-Supported Pier				
<i>Number of Workers</i>	<i>Workers</i>	<i>Miles/Day</i>	<i># of Days</i>	<i>Total Activity</i>
Upland Construction	100	20	540	1,080,000
LWI - PSB Modifications				
<i>Number of Workers</i>	<i>Workers</i>	<i>Miles/Day</i>	<i># of Days</i>	<i>Total Activity</i>
Upland Construction	100	20	540	1,080,000
Service Pier Extension - Either Alternative				
<i>Number of Workers</i>	<i>Workers</i>	<i>Miles/Day</i>	<i># of Days</i>	<i>Total Activity</i>
Upland Construction	70	20	400	560,000

Table 15. Emission Factors for Construction Commuter Vehicles

Project Year/Source Type	grams/mile									
	VOC	CO	NO _x	SO ₂	PM ₁₀	PM _{2.5}	N ₂ O	CH ₄	CO ₂	Notes
Year 2014										
On-Road Vehicles - Composite	1.65	14.06	8.47	0.01	0.44	0.01	0.02	0.07	1189.22	(1)

Note: 1. Emission factors from MOVES - CY2014

Table 16. Air Emissions for Construction Commuter Vehicles

Personnel Activity	Tons									
	VOC	CO	NO _x	SO ₂	PM10	PM _{2.5}	N ₂ O	CH ₄	CO ₂	CO _{2e}
LWI Pile-Supported Pier										
Construction Commuters	1.96	16.73	10.08	0.01	0.52	0.01	0.02	0.08	1415.7	1423.6
Total	1.96	16.73	10.08	0.01	0.52	0.01	0.02	0.08	1415.7	1423.6
LWI - PSB Modifications										
Construction Commuters	1.96	16.73	10.08	0.01	0.52	0.01	0.02	0.08	1415.7	1423.6
Total	1.96	16.73	10.08	0.01	0.52	0.01	0.02	0.08	1415.7	1423.6
Service Pier Extension - Either Alternative										
Construction Commuters	1.02	8.68	5.23	0.01	0.27	0.01	0.01	0.04	734.1	738.2
Total	1.02	8.68	5.23	0.01	0.27	0.01	0.01	0.04	734.1	738.2

Table 17. Operational Emissions for SPE - Support Buildings (tons per year)

	VOC	CO	NO _x	SO ₂	PM ₁₀	PM _{2.5}
SPE	0.07	0.37	0.07	0.00	0.00	0.00

Notes:

Based on 52,000 square feet of the 2 new facilities using Urbemis 2007

Estimated Natural gas usage of 2.0 feet³ / sq. ft/month

Emissions Factors from SCAQMD. 1993. CEQA Air Quality Handbook. Diamond Bar, C

Table 18. Comparison of Air Emissions Total Impacts for LW and SPE Project Alternatives

Alternatives	Total Tons									
	VOC	CO	NO _x	SO ₂	PM ₁₀	PM _{2.5}	N ₂ O	CH ₄	CO ₂	CO _{2e}
LW - Pile-Supported Pier	2.89	22.84	18.49	0.68	1.33	0.75	0.10	0.11	1944.2	1977.5
LW - PSB modifications	2.63	21.97	13.90	0.06	0.81	0.26	0.04	0.10	1699.1	1712.2
Short Pier	2.77	19.36	25.31	1.24	1.63	1.31	0.14	0.14	1878.1	1925.3
Long Pier	3.20	20.40	35.22	1.97	2.26	1.92	0.35	0.19	1948.1	2060.9

N₂O, CH₄, CO₂, and CO_{2e} are in Metric Tons

Table 19. Comparison of Construction-Related Air Emissions for LW Project Alternatives

Alternatives	Tons/Year									
	VOC	CO	NO _x	SO ₂	PM ₁₀	PM _{2.5}	N ₂ O	CH ₄	CO ₂	CO _{2e}
LW - Pile-Supported Pier	2.89	22.84	18.49	0.68	1.33	0.75	0.10	0.11	1944.19	1977.54
LW - PSB modifications	2.63	21.97	13.90	0.06	0.81	0.26	0.04	0.10	1699.14	1712.19

N₂O, CH₄, CO₂, and CO_{2e} are in Metric Tons

Table 20. Comparison of Construction-Related Air Emissions for SPE Project Alternatives

Alternatives	Tons/Year									
	VOC	CO	NO _x	SO ₂	PM ₁₀	PM _{2.5}	N ₂ O	CH ₄	CO ₂	CO _{2e}
Short Pier	2.77	19.36	25.31	1.24	1.63	1.31	0.14	0.14	1878.1	1925.3
Long Pier	3.20	20.40	35.22	1.97	2.26	1.92	0.35	0.19	1948.1	2060.9

N₂O, CH₄, CO₂, and CO_{2e} are in Metric Tons

APPENDIX F

TRAFFIC ANALYSIS

FOR THE CONSTRUCTION OF LAND-WATER INTERFACE AND SERVICE PIER EXTENSION AT NAVAL BASE KITSAP BANGOR

Memo

To: Ted R. Turk, PhD
From: Aruna Mathuranayagam, P.E., P.T.O.E.
CC: Jennifer Wallin
Date: 06/05/2014
Re: Naval Base Kitsap Bangor – Traffic Analysis for Land Water Interface & Service Pier Extension EIS

PROJECT DESCRIPTION

Traffic data review and operational analysis was conducted to study the impacts of the additional trips generated by the construction traffic to the proposed north and south Land Water Interface (LWI) sites and the proposed Service Pier Extension (SPE) site within Naval Base Kitsap (NAVBASE Kitsap) at Bangor. The LWI Proposed Action includes constructing two LWI structures and modifying the existing floating Port Security Barrier (PSB) system. The SPE Proposed Action will require extension of the existing Service Pier and improvements to land-based associated support facilities, including construction of a maintenance support facility, utility upgrades that include an emergency power generator, and a parking lot.

In addition to studying the temporary impacts of the construction traffic along the existing roadway network, traffic operational impacts following the Proposed SPE Action caused by the addition of 322 new employees to the site were also studied.

Proposed construction activity for the LWI projects is expected to occur between May 2016 and May 2018 with most of the soil hauling work completed by 2017. Proposed construction activity for the SPE project is expected to occur between April 2016 and March 2018. Construction of all proposed facilities is anticipated to take approximately 24 months. The area evaluated includes the primary access roads leading to the Naval Base and the internal roadway network within NAVBASE Kitsap Bangor. The primary entrance routes to the base include Trigger Avenue and Trident Boulevard (NW Luoto Road) as they provide direct access from State Route 3 (SR 3), which is the major controlled access roadway serving the base from Bremerton, Poulsbo, Silverdale, and Hood Canal Bridge.

ROADWAY NETWORK

Staging (i.e., parking lot, material/equipment storage, and soil stockpiling) for both LWI project sites would take place at a single site located near the intersection of Archerfish and Seawolf Roads. This site is approximately 5.4 acres (2.2 hectares) in size and has been used recently for staging for other projects. Flier Road and Sealion Road would be the primary haul routes for construction of the LWI north and south project sites.

Staging (i.e., parking lot, material/equipment storage, and soil stockpiling) for the SPE project site would be located at the SPE construction site. The following roadway sections were identified as the primary access and internal roadways under the area of the influence of the proposed LWI and SPE projects within the study area:

- Trigger Avenue south of Trident Boulevard (LWI & SPE),
- Trident Boulevard east of Trigger Avenue (LWI & SPE),
- Trigger Avenue East of Escolar Road (LWI & SPE),
- Escolar Road North of Trigger Avenue (LWI),
- Escolar Road North of Sturgeon Street (LWI),
- Greenling Road West of Archerfish Road (LWI),
- Archerfish Road North of Seawolf Road (LWI),
- Seawolf Road East of Flier Road (LWI North),
- Flier Road North of Seawolf Road (LWI North),
- Trigger Avenue South of Sturgeon Street/Attu Road (LWI South & SPE),
- Sturgeon Street/Attu Road West of Trigger Avenue (LWI South & SPE), and
- Sealion Road North of Sturgeon Street/Attu Road/ (LWI South & SPE).

Of the above shown roadway sections, Trigger Avenue and Trident Boulevard (NW Luoto Road) are multi-lane divided highways serving as primary entrance routes to the base providing access from SR 3.

Similarly, the following intersections were identified as those under the area of the influence of the proposed changes within the study area:

- Trigger Avenue and Ohio Street (LWI & SPE),
- Trigger Avenue and Trident Boulevard (LWI & SPE),
- Trigger Avenue and Escolar Road (LWI & SPE),
- Escolar Road and Sturgeon Street (LWI),
- Escolar Road and Greenling Road (LWI),
- Archerfish Road and Seawolf Road (LWI),
- Seawolf Road and Flier Road (LWI North), and
- Trigger Avenue and Sturgeon Street (LWI South & SPE).

The existing roadway and intersection geometry and intersection control conditions were used in performing the traffic analyses for the baseline traffic conditions, future traffic demand conditions during construction generated by the construction-related activities, and future traffic demand conditions following construction generated by the proposed action improvements. Roadway sections and intersections operating at unacceptable levels of service (LOS) under the various analysis scenarios were identified.

TRAFFIC DATA

Existing Baseline (2011 and 2012) average daily traffic data, and morning and evening peak period intersection turning movement data, along the study area roadway sections and intersections affected by the LWI and SPE projects were obtained from the Parametrix Report completed in February 2011 and traffic counts conducted by All Traffic Data in November 2012. Review of the data indicated that the morning peak hour occurred between 07:00 and 09:00 a.m. and the evening peak hour occurred between 02:00 and 04:00 p.m. The highest hourly traffic demand observed during the morning and evening peak periods was used in developing future projections and conducting traffic operational analysis to determine the LOS.

Table 1 shows the Baseline 2011 and 2012 average daily traffic (ADT) for the key study area roadway sections affected by the proposed construction traffic. Table 2 shows the Baseline 2011 and 2012 overall intersection entering traffic for the study area intersections affected by the proposed construction traffic.

Table 1: Baseline Average Daily Traffic Volumes — NAVBASE Kitsap at Bangor Roadways

Location	Cars / Bikes / SUVs	Trucks /Buses	Total
All Site Traffic:			
Trigger Avenue north of Thresher Avenue	6,854	266	7,120
Trigger Avenue east of Escolar Road	8,676	702	9,378
Trident Boulevard east of Scorpion Avenue	10,830	751	11,581
LWI Site Traffic:			
Escobar Road south of Goldfinch Lane	4,026	226	4,252
Escobar Road north of Sturgeon	3,446	96	3,542
Greenling Road west of Archerfish Road	829	25	854
Archerfish Road north of Tinian Road	446	2	448
LWI North Site Traffic:			
Seawolf Road east of Flier Road	n/a	n/a	510
Flier Road north of Seawolf Road	n/a	n/a	520
LWI South & SPE Site Traffic:			
Trigger Avenue south of Sturgeon Street	n/a	n/a	2,710
Sturgeon Street west of Trigger Avenue	n/a	n/a	3,220
Sealion Road north of Sturgeon Street	n/a	n/a	2,100

Source: Parametrix 2011, All Traffic Data Services, Inc. 2012

Table 2: Baseline Overall Intersection Entering Traffic Volumes — NAVBASE Kitsap at Bangor

Location	Overall Intersection Entering Traffic		Overall Intersection Peak Hour Factor ¹		Overall Intersection Heavy Vehicle Factor	
	AM Peak	PM Peak	AM Peak	PM Peak	AM Peak	PM Peak
All Site Traffic:						
Trigger Avenue/Ohio Street	1,267	1,424	0.94	0.90	1.6%	1.2%
Trigger Avenue/Trident Boulevard	1,693	1,512	0.83	0.79	0.1%	0.1%
Escalar Road/Trigger Avenue	1,445	1,480	0.89	0.77	0.7%	0.9%
LWI Site Traffic:						
Escalar Road/Sturgeon Road	625	460	0.81	0.79	2.7%	3.0%
Escalar Road/Greenling Road	398	347	0.77	0.68	2.0%	0.6%
Archerfish Road/Seawolf Road	91	72	0.84	0.78	1.1%	4.2%
LWI North Site Traffic:						
Seawolf/Flier	45	36	0.70	0.69	13.3%	8.3%
LWI South & SPE Site Traffic:						
Trigger/Sturgeon	313	415	0.84	0.80	3.8%	3.9%

Source: Parametrix 2011, All Traffic Data Services, Inc. 2012

NOTE:

1. Peak hour Factor indicates the hourly volume during the maximum-volume hour of the day divided by the peak 15-min flow rate within the peak hour; a measure of traffic demand fluctuation within the peak hour.

The baseline traffic data were used in developing future projections for the years 2016, 2017, and 2018 for the primary entrance routes to the Naval Base and other internal roadways. Project-generated ADT and intersection turning movement projections for the analysis roadways and intersections within the study area were developed for the years 2016, 2017, and 2018 when the construction activity, and the generated automobile and truck trips, are expected to be at their maximum. The baseline traffic data and intersection turning movement counts were projected using a 1.2% average annual growth factor to determine the future baseline 2016, 2017, and 2018 traffic trips.

Construction-related truck traffic would be generated by the need to deliver construction materials and remove construction debris from the construction sites. Construction debris would be hauled off site to an approved disposal location. Over the duration of construction (24 months), construction workers and large truck traffic including construction vehicles and soil hauling trucks will drive to and from the LWI and SPE construction sites.

LWI Sites:

Over the duration of construction (24 months), a maximum of 100 workers are conservatively assumed to drive to and from the LWI construction sites. General large truck traffic is estimated to be five (5) to ten (10) trips per day on average, while other construction traffic such as inspectors, visitors, and miscellaneous smaller vehicles is estimated to be 30 trips per day on average. Soil hauling is expected to require an additional 1,300 truck trips over a period of 6 months (a minimum of 95 work days) during 2016 and 2016, for a daily average of 15–20 truck trips per day during that period. Based on relative cut and fill volumes, 80 percent of these soil hauling trucks are estimated to go to the north site, while 20 percent are estimated to go to the south site. During peak construction activities, there would be a substantial increase in the peak number of daily truck trips.

SPE Site:

Over the duration of construction (24 months), a maximum of 70 workers are conservatively assumed to drive to and from the SPE construction site. General large truck traffic is estimated to be 18 trips per day on average, while other construction traffic such as inspectors, visitors, and miscellaneous smaller vehicles is estimated to be 70 trips per day on average. Materials and equipment for the in-water work would be brought in by barge, while materials and equipment for upland construction would be brought in by truck.

The estimated trips generated from the construction-related activities were combined with the future projected traffic volumes to obtain the analysis volumes for the years 2016, 2017, and 2018. These were used in performing traffic operational analysis at all the affected roadways and intersections to determine LOS and traffic delays.

The following conditions were used to distribute the generated trips from the construction-related activities along the study area roadways and intersections:

- Automobile traffic will enter from either the gate on Trident Boulevard or Trigger Avenue and head northwesterly towards Escolar Road. A 50/50 percent assumption was used to estimate automobile traffic entering the base via Trident Boulevard and Trigger Avenue.
- Truck traffic will enter the base only at Trident Boulevard. Trucks will then follow the same route as the automobiles.

LWI Sites:

- Traffic accessing the north LWI project site will head north on Escolar Road, traveling east on Greenling Road, and then north on Archerfish Road to reach the construction site via Seawolf and Flier Roads.
- Traffic accessing the south LWI project site will continue along Trigger Avenue west of Escolar Road to access the construction site via Sturgeon and Sealion Roads.
- 90 percent of the soil hauling truck trips will be generated by the LWI north site; these trips will follow the same route as the automobiles: Escolar → Greenling → Archerfish → Seawolf → Flier.

- 10 percent of the soil hauling truck trips will be generated by the south LWI project site; these trips will follow Trigger → Sturgeon → Sealion.
- Construction workers will park at the staging area located near the intersection of Archerfish and Seawolf Roads.

SPE Site:

- Traffic accessing the SPE site will continue along Trigger Avenue west of Escolar Road to access the construction site via Sturgeon → Sealion → Wahoo.
- All traffic will travel to the site and park at the one available parking area.
- Construction workers will also park at the staging/parking area at the site.

The generated trip numbers and traffic distribution patterns were used to determine the future construction trips along all the study area key roadway sections and intersections for the years 2016, 2017, and 2018. The future projected trips along the primary entrance routes of Trigger Avenue and Trident Boulevard are shown in Table 3 and Table 4.

**Table 3: Projected Daily Traffic Volumes along Trident Boulevard / NW Luoto Road
for the LWI & SPE Projects — NAVBASE Kitsap Bangor**

Trip Description	Year 2016	Year 2017	Year 2018
Non-Project Traffic	13,526	13,689	13,853
Construction Worker Automobile Trips - LWI	100	100	100
Soil Hauling Truck Trips - LWI	20	20	0
Other Construction Truck Traffic Trips - LWI	8	8	8
Other Construction Traffic - LWI	30	30	30
Construction Worker Automobile Trips - SPE ¹	70	70	70
Soil Hauling Truck Trips - SPE ¹	0	0	0
Other Construction Truck Traffic Trips - SPE ¹	18	18	18
Other Construction Traffic - SPE ¹	70	70	70
Total	13,842	14,005	14,149

Source: (1) U.S. Navy, email dated Wednesday - 03/20/2013.

**Table 4: Projected Daily Traffic Volumes along Trigger Avenue
for the LWI & SPE Projects — NAVBASE Kitsap Bangor Roadways**

Trip Description	Year 2016	Year 2017	Year 2018
Non-Project Traffic	12,570	12,721	12,873
Construction Worker Automobile Trips - LWI	100	100	100
Soil Hauling Truck Trips - LWI	20	20	0
Other Construction Truck Traffic Trips - LWI	8	8	8
Other Construction Traffic - LWI	30	30	0
Construction Worker Automobile Trips - SPE ¹	70	70	70
Soil Hauling Truck Trips - SPE ¹	0	0	0
Other Construction Truck Traffic Trips - SPE ¹	18	18	18
Other Construction Traffic - SPE ¹	70	70	70
Total	12,886	13,037	13,139

Source: (1) U.S. Navy, email dated Wednesday - 03/20/2013.

TRAFFIC OPERATIONAL ANALYSIS & METHODOLOGY

Traffic analysis to study the impacts of additional traffic generated during construction-related activities and following construction, from proposed action improvements, was performed at signalized intersections and roadway sections. The analysis for signalized intersections was conducted using Synchro/SimTraffic. The analysis for the two-lane and four-lane divided/undivided roadway sections was conducted using the Highway Capacity Software (HCS 2010), which is based on the guidelines listed in the Highway Capacity Manual (HCM) 2010 to determine the LOS. LOS is a measure of traffic operations, which uses a qualitative grading scale from A to F. LOS A represents the best traffic operations and LOS F represents the worst traffic operations. The LOS for multi-lane divided/undivided roadways is defined by vehicular density (vehicles per mile per lane). The LOS for two-lane roadways is defined by average travel speed and percent time spent following. The LOS for signalized and unsignalized intersections is defined by control delay (seconds per vehicle). Table 5 shows the measures of effectiveness used in determining the LOS of the various roadway facilities and intersection control types encompassed within the study area.

Analysis Software - Synchro/SimTraffic

Synchro is a macroscopic signal design software application supported by SimTraffic, the microscopic simulation model. This application was used to determine the LOS for optimized signal timing and phasing conditions at all the signalized and unsignalized intersections within the study area. Synchro is based on the HCM-recommended guidelines for signalized and unsignalized intersections. Synchro models traffic arriving or present at the intersection approaches and does not account for traffic flow or spillback conditions at adjacent intersections.

Table 5: Measures of Effectiveness used in Determining Levels of Service

LOS	At-Grade Un-Signalized Intersection Average Control Delay Per Vehicle (s/veh)	At-Grade Signalized Intersection Control Delay Per Vehicle (s/veh)	Percent Time Spent Following for Two-Lane Highways in Class II
A	0 - 10	≤ 10	≤ 40
B	> 10 - 15	> 10 - 20	> 40-55
C	> 15 - 25	> 20 - 35	> 55-70
D	> 25 - 35	> 35 - 55	> 70-85
E	> 35 - 50	> 55 - 80	> 85
F	> 50	> 80	Note 1

NOTE:

1. LOS F applies whenever the flow rate exceeds the segment capacity

Analysis Software - HCS 2010

The Highway Capacity Software is based on concepts and guidelines outlined in the HCM developed by the Transportation Research Board (TRB) to determine the capacity and quality of service of various roadway facilities that carry both vehicular and non-vehicular traffic. The HCM is a result of a multi-agency effort including TRB, American Association of State Highway and Transportation Officials, and Federal Highway Administration and is a widely used reference for traffic and transportation engineering practice.

ANALYSIS OF ALTERNATIVES

The various scenarios analyzed under the baseline and future morning (a.m.) and evening (p.m.) peak hour traffic demand conditions for the key roadway sections and intersections include the following:

- Baseline Condition 2011 or 2012 (a.m. / p.m. Peak Analysis)
- Future 2016 Condition with Construction Traffic (a.m. / p.m. Peak Analysis)
- Future 2017 Condition with Construction Traffic (a.m. / p.m. Peak Analysis)
- Future 2018 Condition with Construction Traffic (a.m. / p.m. Peak Analysis)

Table 6 shows the morning and evening peak hour LOS and measures of effectiveness values for the intersections within the NAVBASE Kitsap Bangor study area. The LOS shown indicates the combined effect of the added traffic from the LWI project(s) and the SPE project. Results of the intersection operational analysis indicate all of the key intersections operating at acceptable levels of service, LOS A, B, C, or D under the future 2016, 2017 and 2018 traffic demand conditions.

Table 7 shows the morning and evening peak hour LOS and measures of effectiveness values for the roadway sections within the NAVBASE Kitsap Bangor study area. The LOS shown indicates the combined effect of the added traffic from the LWI project(s) and the SPE project. Results of the operational analysis indicate all of the multi-lane and two-lane roadway sections operating at acceptable levels of service, LOS A, B, C, or D, under the future 2016, 2017 and 2018 traffic demand conditions.

LWI Proposed Action Operations:

The proposed LWI action and future operations will not generate additional traffic. Hence, the impacts of this proposed action on the major access roadways, internal base roadway network, and intersections are negligible.

SPE Proposed Action Operations:

The proposed SPE action will require improvements to land-based associated support facilities, including construction of a maintenance support facility, utility upgrades that include an emergency power generator, and a parking lot. The proposed Maintenance Support Facility would be located on an existing parking lot on the east side of Wahoo Road. With the completion of the proposed action, 322 new employees will be added to support the shore-based maintenance activities. This, in turn, will generate additional trips, with the new employee traffic accessing the proposed parking lot. Access to and from the proposed main parking lot will be via Sturgeon Street (Attu Road) controlled by a stop sign. The proposed parking lot will be 6 acres (2.4 hectares) in size and contain 535 parking spaces. Access to the smaller lot for Government vehicles will be via Sealion Road.

A review of the post-construction traffic impacts to the SPE site under the highest peak hour traffic demand conditions also indicated the following:

- Trigger & Sturgeon (a.m. Peak) - LOS C / 18.6 seconds (decline from a LOS B)
- Trigger & Escolar (p.m. Peak) - LOS D / 41.0 seconds (approaching LOS E)

CONCLUSIONS & RECOMMENDATIONS

The construction activity for the proposed Waterfront Restricted Area LWI and SPE actions will add construction traffic to the existing roadway network within NAVBASE Kitsap Bangor and to the primary roadways providing access to the base. Added construction-related traffic will include both automobile and truck traffic. The impact from this additional traffic is estimated to affect traffic operations at the Escolar/Trigger and Escolar/Sturgeon and Trigger/Sturgeon intersections. Similarly, the additional traffic will also impact the operations of the roadway sections along Escolar Road between Trigger and Greenling, Greenling Road, Archerfish Road and Flier Road; Trigger Avenue between Escolar and Sturgeon, Sturgeon Street and Sealion Road. In spite of the additional construction-related traffic, the existing roads planned for construction traffic could accommodate the additional vehicles and trucks, and would not need to be upgraded to accommodate construction traffic. However, the additional traffic volumes may create longer wait times to enter the base, particularly during the a.m. peak hour, as vehicles queue up to pass through the security checkpoint.

To maintain a LOS D along the roadways providing access to the SPE site post, the proposed action, the following improvements are recommended:

- Trigger & Escolar Intersection - Widen southbound approach to add an additional left turn lane
- Sturgeon Street - Improve existing street at the parking lot access drive

Road improvements to accommodate changes in traffic patterns along Wahoo and Sealion roads as well as repairs to existing roads damaged from construction activity are included as part of the SPE alternative.

REFERENCES

- All Traffic Data Services. 2012. Traffic counts at various NAVBASE Kitsap Bangor intersections, November 2012. All Traffic Data Services, Inc., Renton, WA.
- Parametrix. 2011. Technical Memorandum: Bangor traffic analysis - construction of EHW-2. Prepared by Cindy Clark, Parametrix, Poulsbo, WA. Prepared for SAIC, Bothell, WA. February 11, 2011.
- U.S. Navy. 2013. Curtis Hickle, SPE Project Manager, NAVFAC Northwest, Silverdale, WA. Email, March 20, 2013. Personal communication with Ted Turk, Senior Project Manager, Science Applications International Corporation, Bothell, WA, re: SPE construction and operations information.

Table 6: Peak Hour Intersection Level of Service Analysis for the LWI & SPE Proposed Actions – NAVBASE Kitsap Bangor

Intersection	AM Peak						PM Peak					
	BASELINE			FUTURE WITH CONSTRUCTION TRAFFIC			BASELINE			FUTURE WITH CONSTRUCTION TRAFFIC		
	2011 / 2012		2016	2017		2018	2011 / 2012		2016	2017		2018
	LOS (seconds)	Delay (seconds)	LOS	Delay (seconds)	LOS	Delay (seconds)	LOS (seconds)	Delay (seconds)	LOS	Delay (seconds)	LOS	Delay (seconds)
All Site Traffic:												
Trigger & Ohio	B	11.2	B	11.7	B	11.9	B	11.9	B	12.6	B	12.9
Trigger & Trident	B	19.8	C	24.5	C	24.7	C	24.9	B	10.2	B	12.1
Trigger & Escalator	A	5.5	A	7.9	A	8.0	A	8.1	D	37.9	D	47.8
LWI Site Traffic:												
Escalar & Surgeon	B	14.3	C	16.9	C	17.1	C	17.2	C	22.9	D	26.1
Escalar & Greenling	B	11.5	C	16.2	C	16.1	C	16.8	A	9.9	B	13.7
Archerfish & Seawolf	A	9.4	B	11.4	B	11.4	B	11.6	A	9.3	B	11.2
LWI North Site Traffic:												
Seawolf & Flier	A	8.9	A	9.3	A	9.3	A	9.4	A	9.3	A	9.5
LWI South & SPE Site Traffic:												
Trigger & Surgeon	B	11.1	B	14.1	B	14.2	B	14.3	B	100	B	10.9

NOTE:

1. Default values used in determining the LOS were obtained from Parametrix 2011 Bangor Traffic Analysis-Construction of EHW Impacts (Technical Memorandum)
2. LOS values shown for the unsignalized intersections are for the stop-controlled movements experiencing the highest delay.
3. LOS values shown indicate the combined impacts of the LWI and SPE projects.
4. LOS = Level of Service

Table 7: Peak Hour Roadway Sections Level of Service Analysis for the LWI & SPE Proposed Actions – NAVBASE Kitsap Bangor

Roadway Section	Multi-Lane Roadway Sections										PM Peak									
	AM Peak					FUTURE WITH CONSTRUCTION TRAFFIC					BASELINE					FUTURE WITH CONSTRUCTION TRAFFIC				
	2011/2012		2016		2017		2018		2011/2012		2016		2017		2018		2016		2017	
	LOS	Density (veh/mile/lane)	LOS	Density (veh/mile/lane)	LOS	Density (veh/mile/lane)	LOS	Density (veh/mile/lane)	LOS	Density (veh/mile/lane)	LOS	Density (veh/mile/lane)	LOS	Density (veh/mile/lane)	LOS	Density (veh/mile/lane)	LOS	Density (veh/mile/lane)	LOS	Density (veh/mile/lane)
LWI Site Traffic:																				
Trigger north of Thresher	A	7.8	A	9.4	A	9.5	A	9.6	A	6.7	A	8.3	A	8.4	A	8.5	A	8.4	A	8.5
Trigger north of Trigger	A	7.2	A	8.8	A	8.9	A	9.0	A	6.9	A	8.3	A	8.4	A	8.5	A	8.4	A	8.5
Trigger north of Trident	B	14.8	C	18.5	C	18.7	C	18.9	B	13.0	B	16.5	B	16.7	B	16.9	B	16.7	B	16.9
LMSouth & SPE Site Traffic:																				
Trigger east of Escalar	B	14.3	C	19.4	C	19.6	C	19.8	B	14.7	C	18.3	C	18.4	C	18.5	C	18.4	C	18.5
Trigger south of Sturgeon/Attu	A	2.3	A	3.8	A	3.9	A	3.9	A	3.5	A	4.9	A	5.0	A	5.1	A	5.0	A	5.1
Two-Lane Roadway Sections																				
Roadway Section	AM Peak					FUTURE WITH CONSTRUCTION TRAFFIC					BASELINE					FUTURE WITH CONSTRUCTION TRAFFIC				
	2011/2012		2016		2017		2018		2011/2012		2016		2017		2018		2016		2017	
	LOS	Percent Time Spent Following (PTS%)	LOS	Percent Time Spent Following (PTS%)	LOS	Percent Time Spent Following (PTS%)	LOS	Percent Time Spent Following (PTS%)	LOS	Percent Time Spent Following (PTS%)	LOS	Percent Time Spent Following (PTS%)	LOS	Percent Time Spent Following (PTS%)	LOS	Percent Time Spent Following (PTS%)	LOS	Percent Time Spent Following (PTS%)	LOS	Percent Time Spent Following (PTS%)
LWI Site Traffic:																				
Escalar north of Trigger	D	79.5%	D	83.1%	D	83.2%	D	83.3%	D	76.7%	D	80.9%	D	81.1%	D	82.2%	D	82.2%	D	82.2%
Escalar north of Sturgeon	D	72.3%	D	73.8%	D	73.9%	D	73.9%	C	68.8%	D	73.4%	D	73.5%	D	73.5%	D	73.5%	D	73.5%
Greenling west of Archefish	C	58.9%	C	65.6%	C	66.6%	C	66.7%	B	51.3%	C	63.6%	C	63.7%	C	63.7%	C	63.7%	C	63.7%
Seawolf east of Archefish	B	46.2%	C	60.4%	C	60.5%	C	60.5%	A	31.8%	C	57.8%	C	57.8%	C	57.8%	C	57.8%	C	57.8%
LMSouth Site Traffic:																				
Flier north of Seawolf	A	37.1%	B	40.9%	B	40.9%	B	41.0%	A	38.7%	B	44.5%	B	44.5%	B	44.6%	B	44.6%	B	44.6%
LMSouth & SPE Site Traffic:																				
Sturgeon/Attu west of Trigger	C	67.3%	D	72.8%	D	72.8%	D	72.9%	D	71.9%	D	73.9%	D	73.9%	D	74.0%	D	74.0%	D	74.0%
Sealion north of Attu	C	62.1%	C	69.0%	C	69.1%	D	69.2%	C	66.1%	D	72.0%	D	72.0%	D	72.3%	D	72.3%	D	72.3%

NOTE:

1. Default values used in determining the LOS were obtained from Parametrix 2011 Bangor Traffic Analysis-Construction of EHW Impacts [Technical Memorandum]

2. LOS values shown indicate the cumulative impacts of the LWI and SPE projects.

3. LOS = Level of Service

APPENDIX G

REGULATORY COMPLIANCE AND CONSULTATION

TABLE OF CONTENTS

Notice of Intent to Prepare EIS.....	G-1
Cooperating Agencies for EIS	G-7
Tribes and Cultural Resources.....	G-21
Regulatory Consultations	G-71

This page is intentionally blank.

Notice of Intent to Prepare EIS

This page is intentionally blank.



7416

Federal Register / Vol. 78, No. 22 / Friday, February 1, 2013 / Notices

9:00 a.m.–9:15 a.m. Public Forum
 9:15 a.m.–10:15 a.m. Navy Safe Harbor Response to RWTF FY12 Recommendations
 10:15 a.m.–10:30 a.m. Break
 10:30 a.m.–12:15 p.m. Navy Harbor Survey Program
 12:15 p.m.–1:15 p.m. Break for Lunch
 1:15 p.m.–2:15 p.m. Marine Corps Response to RWTF FY12 Recommendations
 2:15 p.m.–3:00 p.m. Marine Corps Wounded Warrior Regiment Survey Program
 3:00 p.m.–3:15 p.m. Break
 3:15 p.m.–4:15 p.m. Marine Corps Wounded Warrior Regiment Survey Program (continued)
 4:45 p.m.–5:00 p.m. Wrap Up

Public's Accessibility to the Meeting:
 Pursuant to 5 U.S.C. 552b and 41 CFR 102–3.140 through 102–3.165, and the availability of space, this meeting is open to the public. Seating is on a first-come basis.

Pursuant to 41 CFR 102–3.105(j) and 102–3.140, and section 10(a)(3) of the Federal Advisory Committee Act of 1972, the public or interested organizations may submit written statements to the Department of Defense Task Force on the Care, Management, and Transition of Recovering Wounded, Ill, and Injured Members of the Armed Forces about its mission and functions. If individuals are interested in making an oral statement during the Public Forum time period, a written statement for a presentation of two minutes must be submitted and must identify it is being submitted for an oral presentation by the person making the submission. Identification information must be provided and at a minimum must include a name and a phone number. Individuals may visit the Task Force Web site at <http://dtf.defense.gov/rwtf/> to view the Charter. Individuals making presentations will be notified by Wednesday, February 20, 2013. Oral presentations will be permitted only on Wednesday, February 27, 2013 from 9:00 a.m. to 9:15 a.m. EDT before the Task Force. The number of oral presentations will not exceed ten, with one minute of questions available to the Task Force members per presenter. Presenters should not exceed their two minutes.

Written statements in which the author does not wish to present orally may be submitted at any time or in response to the stated agenda of a planned meeting of the Department of Defense Task Force on the Care, Management, and Transition of Recovering Wounded, Ill, and Injured Members of the Armed Forces.

All written statements shall be submitted to the Designated Federal Officer for the Task Force through the contact information in **FOR FURTHER INFORMATION CONTACT**, and this individual will ensure that the written statements are provided to the membership for their consideration. Statements, either oral or written, being submitted in response to the agenda mentioned in this notice must be received by the Designated Federal Officer at the address listed in **FOR FURTHER INFORMATION CONTACT** no later than 5:00 p.m. EDT, Monday, February 18, 2013 which is the subject of this notice. Statements received after this date may not be provided to or considered by the Task Force until its next meeting. Please mark mail correspondence as "Time Sensitive for February Meeting."

The Designated Federal Officer will review all timely submissions with the Task Force Co-Chairs and ensure they are provided to all members of the Task Force before the meeting that is the subject of this notice.

Reasonable accommodations will be made for those individuals with disabilities who request them. Requests for additional services should be directed to Ms. Heather Moore, (703) 325–6640, by 5:00 p.m. EDT, Monday, February 18, 2013.

Dated: January 29, 2013.

Aaron Siegel,

Alternate OSD Federal Register Liaison Officer, Department of Defense.

[FR Doc. 2013–02172 Filed 1–31–13; 8:45 am]

BILLING CODE 5001–06–P

Water Interface (LWI) structures and (2) the proposed construction and operation of a Service Pier Extension (SPE) on Naval Base (NAVBASE) Kitsap Bangor.

The DoN proposes two projects on NAVBASE Kitsap Bangor waterfront to: (1) Comply with Department of Defense (DoD) directives to protect Navy OHIO Class ballistic missile submarines (TRIDENT submarines) from increased and evolving threats and to prevent the seizure, damage, or destruction of military assets and (2) eliminate deployment constraints and improve maintenance of SEAWOLF Class submarines.

The first proposed action includes constructing two LWI structures and modifying the existing floating Port Security Barrier (PSB) system for improved protection of TRIDENT submarines. Construction of the LWI structures would enclose the Navy Waterfront Restricted Area (WRA) on NAVBASE Kitsap Bangor by constructing security barriers in the intertidal zone at the Bangor waterfront. Construction is anticipated to take two years. Construction activities occurring in the water during the first year may involve pile driving and would be conducted July 2015 through February 2016. Once the pile driving is complete, activities other than pile driving may occur in the water up until February 2017.

The second proposed action would relocate SEAWOLF Class submarines SSN–21 (SEAWOLF) and SSN–22 (CONNECTICUT) from NAVBASE Kitsap Bremerton to join SSN–23 (JIMMY CARTER) at NAVBASE Kitsap Bangor. The existing Service Pier would be extended and land based associated support facilities would be constructed including a Maintenance Support Facility, and utility upgrades including an emergency power generator, and a parking lot. Shore based facilities constructed on the pier would include a Pier Services and Compressor Building and a pier crane. Construction would occur from April 2015 to March 2017. Construction in the water is planned for July through February of each year, beginning in July 2015 and concluding in February 2017. The relocation would result in the consolidation of berthing and support for the SEAWOLF Class submarines at NAVBASE Kitsap Bangor.

NAVBASE Kitsap is the action proponent. The LWI construction and PSB modifications are for the DoN's Strategic Systems Programs (SSP), which directs research, development, manufacturing, test, evaluation, and operational support of the TRIDENT

DEPARTMENT OF DEFENSE

Department of the Navy

Notice of Intent To Prepare an Environmental Impact Statement for Land-Water Interface and Service Pier Extension, Naval Base Kitsap Bangor, Silverdale, WA and To Announce Public Scoping Meetings

AGENCY: Department of the Navy, DoD.
ACTION: Notice.

SUMMARY: Pursuant to section (102)(2)(c) of the National Environmental Policy Act (NEPA) of 1969 and the regulations implemented by the Council on Environmental Quality (CEQ) (40 CFR parts 1500–1508), the Department of the Navy (DoN) announces its intent to prepare an Environmental Impact Statement (EIS) to evaluate the potential environmental impacts associated with two actions: (1) The proposed construction and operation of Land-

program. The SPE and supporting facilities are for Commander, Submarine Development Squadron Five (CSDS-5). CSDS-5 is the Immediate Superior in Command for all three SEAWOLF Class submarines and four DoN research, development, test, and evaluation (RDT&E) detachments based at NAVBASE Kitsap Bangor.

The DoN is the lead federal agency for this action. The DoN is requesting the U.S. Army Corps of Engineers and the National Marine Fisheries Service to be Cooperating Agencies. The DoN will hold public scoping meetings to receive oral and/or written comments on environmental concerns related to the proposed actions, to determine the scope of issues to address in the Draft EIS, and to identify and refine alternatives to the proposed actions. Federal, state, and local agencies, American Indian tribes, and the public are invited to participate in the scoping process.

The public scoping meetings will be conducted in English and will be arranged in an informal, open-house format. Attendees will be provided the opportunity to sign in and then visit various stations hosted by DoN representatives and technical staff assigned to provide information and answer questions. Several large display boards will be located throughout the meeting locations to assist attendees in understanding the proposed actions and the alternatives. Fact sheets about the proposed actions and alternatives will be available to attendees. A comment table with comment sheets will be placed in an easily accessible location.

DATES AND ADDRESSES: The public scoping meetings will be held on the following dates and locations:

1. February 20, 2013 from 5:00 p.m. to 8:00 p.m. at the Chimacum High School Commons, 91 West Valley Road, Chimacum, WA 98325; and

2. February 21, 2013 from 5:00 p.m. to 8:00 p.m. at the North Kitsap High School Commons, 1780 Northeast Hostmark Street, Poulsbo, WA 98370.

FOR FURTHER INFORMATION CONTACT: Naval Facilities Engineering Command Northwest, Attn: Thomas Dildine, LWI/SPE EIS Project Manager, 1101 Tautog Circle, Silverdale, WA 98315-1101. Email: nwnepa@navy.mil, Phone: 360-396-6387, or Web site: www.nfkeis.com/lwi/.

SUPPLEMENTARY INFORMATION: The purpose of the LWI project is to (1) comply with DoD directives to protect TRIDENT submarines from increased and evolving threats and to prevent the seizure, damage, or destruction of military assets. The purpose of the SPE

project is to eliminate deployment constraints and improve maintenance of SEAWOLF Class submarines.

The need for the LWI is to:

- Enhance security within the WRA. Protection of strategic military assets is a vital national security concern. Aggressive security improvements within the DoN pre-date the USS Cole incident and the terrorist attacks of September 11, 2001 and continue today.

The need for the SPE is to:

- Remove restrictions on navigating SEAWOLF Class submarines through Rich Passage under certain tidal conditions;
- Improve long-term operational effectiveness for the three SEAWOLF Class submarines at NAVBASE Kitsap Bangor;
- Provide berthing and logistical support at the DoN's submarine RDT&E hub, which is located on NAVBASE Kitsap Bangor; and
- Improve submarine crew training and readiness through co-location of the SEAWOLF Class submarines and crew with command functions at NAVBASE Kitsap Bangor submarine training center.

The LWI and SPE are related actions due to their proximity, anticipated timing of construction, and potential to affect similar resources, but are not connected projects because each proposed action would function independently. While independent in function, the projects may have the potential to affect related resources, so the DoN has chosen to analyze both projects in a single EIS.

The EIS must evaluate reasonable alternatives in accordance with the CEQ regulations (40 Code of Federal Regulations [CFR] § 1502.14) and DoN regulations (32 CFR Part 775) that implement the NEPA. Alternatives for the proposed action were identified based on security and program requirements, avoiding or minimizing environmental impacts, and compatibility with existing facilities, infrastructure, and operational missions.

The DoN is considering the following alternatives to satisfy each purpose and need:

(i) **LWI Alternative 1 (No Action)**—Under the No Action Alternative, the DoN would not build the LWI and associated PSB modifications. DoD and DoN security requirements for the TRIDENT program would not be met.

(ii) **LWI Alternative 2 (Pile-Supported Pier and PSB Modification)**—Under this alternative, the LWI structure would include two pile-supported piers built from shoreline abutments to connect with the existing PSB system at the north and south sides of the NAVBASE

Kitsap Bangor WRA. Each pier would connect to a solid concrete abutment to be constructed on the shore, and an anchoring structure for the PSBs to be installed at the seaward end of each pier. The LWI pier structure would be 280 feet long at the northern location and 730 feet long at the southern location. The piers would be supported by up to fifty-four 24-inch diameter steel piles at the northern location and up to eighty-two 24-inch diameter steel piles at the southern location. A fence would be installed along the length of the piers, five 30 foot tall towers would be installed on the piers to support lights and cameras, and a mesh/grate with sensors would extend from the bottom of the pier walkway to the seafloor.

(iii) **LWI Alternative 3 (Port Security Barrier Modification)**—This alternative, the DoN would build the LWI using PSBs instead of a pile supported pier. The LWI structures would consist of modifying and lengthening the existing PSBs at the same north and south locations as the pile supported pier alternative. The PSB sections would be 280 feet long at the northern location and 730 feet long at the southern location. The existing PSB system would be modified and lengthened to extend across the intertidal zone and would attach to shoreline abutments. Two solid concrete abutments would be constructed at the shore end of the north and south location to form a secure barrier from the bluff to the intertidal zone. Three 30 foot tall in-water towers would be installed to support lights and security equipment. The in-water towers would each be supported by a platform resting on four 24 inch piles. Two additional 30 foot tall towers would be installed on land.

(iv) **SPE Alternative 1 (No Action)**—The DoN would not consolidate SEAWOLF berthing and support services. The SEAWOLF Class submarines would continue to have reduced operational availability (due to tide windows limiting safe navigation through Rich Passage) and the long-term operations and maintenance efficiency and effectiveness resulting from consolidation of SEAWOLF Class submarines in one location would not occur.

(v) **SPE Alternative 2 (Short Pier Configuration)** The DoN would consolidate SEAWOLF Class submarines on NAVBASE Kitsap Bangor and build and operate the SPE proposed action using a side by side submarine mooring configuration. The proposed new facilities associated with this option include a 600-lineal-foot SPE, a 3,100-square-foot Pier Services and Compressor Building, a pier crane, a

7418

Federal Register / Vol. 78, No. 22 / Friday, February 1, 2013 / Notices

50,000-square-foot shoreside Maintenance Support Facility, and a shoreside emergency diesel generator facility. The new Maintenance Support Facility would be built within an existing parking lot. To support additional personnel, a 6-acre upland parking lot and lay down area would be constructed near the proposed Maintenance Support Facility. The SPE would be supported by approximately 320 steel piles.

(vi) SPE Alternative 3 (Long Pier Configuration)—The DoN would consolidate SEAWOLF Class submarines on NAVBASE Kitsap Bangor and build and operate the SPE proposed action using an in-line berth submarine mooring configuration. The proposed new facilities associated with this option include a 1,200-lineal-foot SPE, a 3,100-square-foot Pier Services and Compressor Building, a pier crane, a 50,000-square-foot shoreside Maintenance Support Facility, and a shoreside emergency diesel generator facility. The new Maintenance Support Facility would be built within an existing parking lot. To support additional personnel, a 6-acre upland parking lot and lay down area would be constructed near the proposed Maintenance Support Facility. The SPE would be supported by approximately 700 steel piles.

The proposed actions will be designed to minimize environmental impacts to the extent practicable. Project details including construction methods, schedule, operations, and maintenance, will be developed during the design process and analyzed in the Draft EIS.

No decision will be made to implement any alternative until the EIS process is completed and a Record of Decision is signed by the acting Principal Deputy Assistant Secretary of the Navy (Energy, Installations, and Environment).

The impacts to be evaluated include, but will not be limited to, effects on federally listed threatened and endangered species and critical habitat, impacts relating to underwater noise and airborne noise from pile driving and other actions, loss of eelgrass and other marine habitat, decreased opportunities for migratory and transient movement of fish and wildlife within the waterfront, reduction in water quality, effects on littoral drift (shoreline sediment movement), and effects on tribal resources.

The analysis will include an evaluation of direct, indirect, short-term, and long-term impacts of construction and operation of each project as well as cumulative impacts

from other DoN and non-DoN activities in the project area.

The DoN is initiating the scoping process to identify community concerns and local issues to be addressed in the EIS. Federal, state, and local agencies, American Indian tribes, and interested persons are encouraged to provide written comments at scheduled public scoping meetings. All written statements will become part of the public record and will be responded to in the Draft EIS.

Written comments should be mailed to Naval Facilities Engineering Command Northwest, 1101 Tantog Circle, Silverdale, WA 98315–1101. Attention: Thomas Dildine, LWI/SPE EIS Project Manager. Comments may also be submitted online at <https://www.nbkceis.com/lwi/> during the comment period. All comments must be received by March 17, 2013 to ensure they become part of the official record.

Dated: January 28, 2013.

C.K. Chiappetta,

Lieutenant Commander, Office of the Judge Advocate General U.S. Navy, Federal Register Liaison Officer.

[PR Doc. 2013-02176 Filed 1-31-13; 8:45 am]

BILLING CODE 3810-FF-P

DEPARTMENT OF EDUCATION

[Docket No.: ED-2013-ICCD-0008]

Agency Information Collection Activities; Submission to the Office of Management and Budget for Review and Approval; Comment Request; High School Longitudinal Study of 2009 (HSLS:09) High School Transcript and 2013 Update Full Scale Study and Panel Maintenance

AGENCY: Department of Education (ED), Institute of Education Sciences.

ACTION: Notice.

SUMMARY: In accordance with the Paperwork Reduction of 1995 (44 U.S.C. chapter 3501 *et seq.*), ED is proposing a revision of an existing information collection.

DATES: Interested persons are invited to submit comments on or before March 4, 2013.

ADDRESSES: Comments submitted in response to this notice should be submitted electronically through the Federal eRulemaking Portal at <http://www.regulations.gov> by selecting Docket ID number ED-2013-ICCD-0008 or via postal mail, commercial delivery, or hand delivery. Please note that comments submitted by fax or email and those submitted after the comment

period will not be accepted. Written requests for information or comments submitted by postal mail or delivery should be addressed to the Director of the Information Collection Clearance Division, U.S. Department of Education, 400 Maryland Avenue SW., LBJ, Room 2E105, Washington, DC 20202–4537.

FOR FURTHER INFORMATION CONTACT: Electronically mail ICDocketMgr@ed.gov. Please do not send comments here.

SUPPLEMENTARY INFORMATION: The Department of Education (ED), in accordance with the Paperwork Reduction Act of 1995 (PRA) (44 U.S.C. 3506(c)(2)(A)), provides the general public and Federal agencies with an opportunity to comment on proposed, revised, and continuing collections of information. This helps the Department assess the impact of its information collection requirements and minimize the public's reporting burden. It also helps the public understand the Department's information collection requirements and provide the requested data in the desired format. ED is soliciting comments on the proposed information collection request (ICR) that is described below. The Department of Education is especially interested in public comment addressing the following issues: (1) Is this collection necessary to the proper functions of the Department; (2) will this information be processed and used in a timely manner; (3) is the estimate of burden accurate; (4) how might the Department enhance the quality, utility, and clarity of the information to be collected; and (5) how might the Department minimize the burden of this collection on the respondents, including through the use of information technology. Please note that written comments received in response to this notice will be considered public records.

Title of Collection: High School Longitudinal Study of 2009 (HSLS:09) High School Transcript and 2013 Update Full Scale Study and Panel Maintenance.

OMB Control Number: 1850–0852.

Type of Review: Revision of an existing information collection.

Respondents/Affected Public: State, Local or Tribal Governments; Individuals or households.

Total Estimated Number of Annual Responses: 34,184.

Total Estimated Number of Annual Burden Hours: 9,975.

Abstract: The High School Longitudinal Study of 2009 (HSLS:09) is a nationally representative, longitudinal study of more than 20,000 9th graders in 944 schools who will be followed

This page is intentionally blank.

Cooperating Agencies for EIS

This page is intentionally blank.



DEPARTMENT OF THE NAVY
OFFICE OF THE CHIEF OF NAVAL OPERATIONS
2000 NAVY PENTAGON
WASHINGTON, DC 20350-2000

IN REPLY REFER TO
5090
Ser N454E/13U139593
21 February 2013

Mr. Samuel D. Rauch III
Assistant Administrator, Acting
National Marine Fisheries Service
1315 East West Highway
Silver Springs, MD 20910

Dear Mr. Rauch:

In accordance with the National Environmental Policy Act (NEPA), the Department of the Navy (Navy) is initiating the preparation of an Environmental Impact Statement (EIS) and is requesting that the National Marine Fisheries Service (NMFS) serve as a cooperating agency. The EIS will evaluate potential environmental effects associated with two proposed actions: 1) the proposed construction and operation of Land-Water Interface (LWI) structures, and; 2) the proposed construction and operation of a Service Pier Extension (SPE) at Naval Base (NAVBASE) Kitsap Bangor, Silverdale, Washington. The purpose of the LWI proposed action is to comply with Department of Defense directives to protect Navy OHIO-class ballistic missile submarines (TRIDENT submarines) from increased and evolving threats and to prevent the seizure, damage, or destruction of military assets. The need for the LWI proposed action is to enhance security within the Waterfront Restricted Area (WRA). The purpose of the SPE proposed action is to eliminate deployment constraints and improve the maintenance of SEAWOLF-class submarines. The need for the SPE proposed action is to remove restrictions on navigating SEAWOLF-class submarines through Rich Passage under certain tidal conditions, improve long-term operational effectiveness for the three SEAWOLF-class submarines at NAVBASE Kitsap Bangor, provide berthing and logistical support at the Navy's submarine Research Development Test and Evaluation hub, and improve submarine crew training and readiness.

The LWI proposed action for the LWI SPE EIS is to:

- Construct two LWI structures and modify the existing floating Port Security Barrier system to enclose the Navy WRA in Hood Canal;
- Construction is anticipated to occur over a two year period. Construction activities occurring in the water during the first year may involve pile driving and would be conducted from July 2015 through February 2016. Once pile driving is complete, activities other than pile driving may occur in the water up until February 2017.

The SPE proposed action for the LWI SPE EIS is to:

- Relocate SEAWOLF-class submarines USS *SEAWOLF* (SSN-21) and USS *CONNECTICUT* (SSN-22) from NAVBASE Kitsap Bremerton to join USS *JIMMY CARTER* (SSN-23) at NAVBASE Kitsap Bangor;
- Extend the existing Service Pier in deeper waters of Hood Canal and construct and operate shore-based support facilities on the pier including a pier services and compressor building and a pier crane;
- Construct and operate associated land-based support facilities including a maintenance support facility and utility upgrades such as an emergency power generator facility and parking lot;
- Construction is anticipated to occur from April 2015 through March 2017. Construction in the water is planned for July through February of each year, beginning in July 2015 and concluding in February 2017.

The LWI and SPE are related actions due to their proximity, anticipated timing of construction, and potential to affect similar resources, but they are not connected projects because each proposed action would function independently. While independent in function, the projects may have the potential to affect related resources, so the Navy chose to analyze both projects in a single EIS. In order to adequately evaluate the potential environmental effects of the proposed actions, the Navy and NMFS will benefit from working together on assessing potential effects to marine species protected under the Marine Mammal Protection Act and the Endangered Species Act. It is anticipated that the effects will predominantly be related to underwater noise and airborne noise from pile driving and the loss of eelgrass and other marine habitat. Other potential effects include effects to federally listed threatened and endangered species and critical habitat, decreased opportunities for migratory and transient movement of fish and wildlife within the waterfront, reduction in water quality, effects on littoral drift (shoreline sediment movement), and effects on tribal resources.

To assist in the LWI SPE EIS planning and in accordance with the Council on Environmental Quality's (CEQ) NEPA guidelines (specifically 40 Code of Federal Regulations (CFR) Part 1501) and CEQ's 2002 guidance on cooperating agencies, the Navy requests that NMFS serve as a cooperating agency for the development of this EIS. As NMFS has jurisdiction by law and special expertise over protected marine species potentially affected by the proposed action, the Navy is requesting that NMFS be a cooperating agency as defined in 40 CFR 1501.6.

As the lead agency, the Navy will be responsible for overseeing preparation of the EIS that includes, but is not limited to, the following:

- Gather all necessary background information and prepare the EIS and all necessary permit applications.
- Work with NMFS personnel to determine the method of estimating potential effects to protected marine species, including threatened and endangered species.

- Use the environmental analysis and proposals of NMFS, to the maximum extent possible.
- Determine the scope of the EIS, including the alternatives evaluated with assistance of NMFS.
- Circulate the appropriate NEPA documentation to the general public and any other interested parties.
- Schedule and supervise meetings held in support of the NEPA process, and compile and respond to any comments received. Meet with NMFS at their request.
- Maintain an administrative record.
- Respond to any Freedom of Information Act requests relating to the EIS.

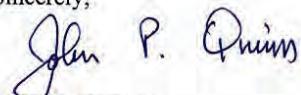
The Navy respectfully requests that NMFS, in its role as cooperating agency, provide support as follows:

- Provide timely comments during the public scoping period and on working drafts of the EIS documents. The Navy requests that comments on draft EIS documents be provided within 30 calendar days.
- Assist the Navy in determining appropriate avoidance, minimization, and/or mitigation measures to incorporate into the proposed action.
- Respond to Navy requests for information in a timely manner.
- Participate, as necessary, in meetings hosted by the Navy for discussion of issues related to the EIS, including public hearings and meetings.
- Adhere to the overall schedule as set forth by the Navy.
- Provide a formal, written response to this request.

The Navy views this agreement as important to the successful completion of the environmental planning process for the LWI SPE EIS. It is the Navy's goal to complete the analysis as expeditiously as possible, while using the best scientific information available. NMFS assistance will be invaluable in that endeavor.

The point of contact for this action is Ms. Karen M. Foskey, (703) 695-5193, email: Karen.Foskey@navy.mil.

Sincerely,



JOHN P. QUINN
Deputy Director, Energy and Environmental
Readiness Division (OPNAV N45)

Copy to:

ASN (EI&E)
DASN (Environment)
OAGC (EI&E)
CNIC WASHINGTON DC
NAVFAC WASHINGTON DC
COMNAVREG NW SILVERDALE WA (N3, N40, N45, N00L)
NAVFAC NW SILVERDALE WA (N00)
COMNAVBASE Kitsap Bangor

MAR 26 2013



UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
1315 East-West Highway
Silver Spring, Maryland 20910
THE DIRECTOR

Mr. John P. Quinn
Deputy Director, Energy and Environmental
Readiness Division
Department of the Navy
2000 Navy Pentagon
Washington, DC 20350-2000

Dear Mr. Quinn:

Thank you for your letter requesting that NOAA's National Marine Fisheries Service (NMFS) be a cooperating agency in the preparation of an Environmental Impact Statement (EIS) to evaluate potential environmental effects associated with the proposed construction and operation of Land-Water Interface structures and a Service Pier Extension at Naval Base Kitsap Bangor. We support the Navy's decision to prepare an EIS on these activities and agree to be a cooperating agency, due, in part, to our responsibilities under section 101(a)(5) of the Marine Mammal Protection Act and section 7 of the Endangered Species Act.

We will make every effort to support the Navy in the specific ways described in your letter. Therefore, to the maximum extent practicable, NMFS will:

- Provide timely comments during the public scoping period and on working drafts of the EIS documents.
- Assist the Navy in determining appropriate avoidance, minimization, and/or mitigation measures to incorporate into the proposed action.
- Respond to Navy requests for information in a timely manner.
- Participate, as necessary, in meetings hosted by the Navy for discussion of issues related to the EIS, including public hearings and meetings.
- Adhere to the overall schedule as set forth by the Navy to the degree possible.

If you have any questions or need additional information, please contact Ms. Helen Golde, NMFS Office of Protected Resources, at (301) 427-8420.

Sincerely,

Samuel D. Rauch III
Deputy Assistant Administrator
for Regulatory Programs,
performing the functions and duties of the
Assistant Administrator for Fisheries

THE ASSISTANT ADMINISTRATOR
FOR FISHERIES



Printed on Recycled Paper

This page is intentionally blank.



DEPARTMENT OF THE NAVY
NAVAL BASE KITSAP
120 SOUTH DEWEY ST
BREMERTON, WA 98314-5020

5090
Ser PRB4/00271
15 Feb 13

From: Commanding Officer, Naval Base Kitsap
To: Colonel Bruce Estok, Commander and District Engineer, U.S.
Army Corps of Engineers, Seattle District

SUBJ: REQUEST U.S. ARMY CORPS OF ENGINEERS SERVE AS
COOPERATING AGENCY FOR ENVIRONMENTAL IMPACT STATEMENT

ENCL: (1) Naval Base Kitsap Notice of Intent to prepare an EIS
(2) LWI/SPE EIS Proposed Action and Alternatives Fact
Sheet

1. The Department of the Navy (Navy) is preparing an Environmental Impact Statement (EIS) to evaluate potential environmental impacts of constructing and operating the Land-Water Interface and Service Pier Extension (LWI/SPE) at Naval Base Kitsap Bangor. In order to adequately evaluate the potential environmental effects of the proposed action and comply with the Clean Water Act, the Navy wishes to initiate enhanced coordination with the Army Corps of Engineers (the Corps) and therefore requests that the Corps consider acting as a cooperating agency for the development of the LWI/SPE EIS in accordance with 40 CFR Part 1501 and the Council on Environmental Quality Cooperating Agency guidance issued on January 30, 2002. Note that the Environmental Impact Statement will include a classified annex.
2. Enclosure (1) contains details about the Navy's Notice of Intent to prepare an EIS. Enclosure (2) is a fact sheet describing the proposed action and alternatives.
3. The Navy values the Corps' knowledge and expertise in wetlands and waters, and views that the Corps participation would be beneficial for both the Navy's EIS process and the Corps' permitting process.
4. The proposed action would add additional overwater structures in Hood Canal and could involve installation of over 800 pilings. The Navy would welcome collaboration with the Corps on data analysis, permitting requirements, and measures to avoid, minimize, and/or mitigate impacts.

SUBJ: REQUEST U.S. ARMY CORPS OF ENGINEERS SERVE AS COOPERATING AGENCY FOR ENVIRONMENTAL IMPACT STATEMENT

5. As a cooperating agency, the Navy requests the Corps support the Navy in the following manner:

- a. Attending public scoping meetings.
- b. Providing timely comments during the scoping period and timely review and comments on working drafts of the EIS documents (comments within 3 weeks).
- c. Assisting the Navy in determining appropriate avoidance, minimization and/or mitigation measures to incorporate into the proposed action.
- d. Responding to Navy requests for information in a timely manner.
- e. Participating, as necessary, in meetings hosted by the Navy to discuss wetland and waters issues.
- f. Adhering to the overall schedule as set forth by the Navy.
- g. Providing a formal, written response to this request, agreeing to the support listed in the above bullets.

As lead agency, the Navy will be responsible for preparing the EIS, which will include, but is not limited to:

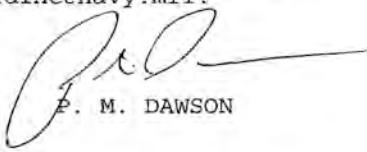
- a. Gathering all necessary background information and preparing the EIS and all necessary permit applications;
- b. Working with Corps personnel to determine the potential effects to wetlands and waters;
- c. Determining the scope of the EIS, including the alternatives evaluated;
- d. Circulating the appropriate NEPA documentation to the general public and any other interested parties;
- e. Scheduling and supervising meetings held in support of the NEPA process and compiling any comments received; and
- f. Maintaining an administrative record and responding to any Freedom of Information Act requests relating to the EIS.

SUBJ: REQUEST U.S. ARMY CORPS OF ENGINEERS SERVE AS
COOPERATING AGENCY FOR ENVIRONMENTAL IMPACT STATEMENT

6. The Navy views this relationship as important to the successful completion of the NEPA process for the LWI/SPE EIS. It is the Navy's goal to complete the analysis as expeditiously as possible, while using the best scientific information available.

7. The Corps' assistance will be invaluable in this endeavor.

8. Points of contact for this action are: Mr. Gregory Leicht, Naval Base Kitsap at (360) 315-4451, gregory.leicht@navy.mil and Mr. Thomas Dildine, Naval Facilities Engineering Command Northwest at (360) 396-0018, thomas.dildine@navy.mil.



P. M. DAWSON

Copy to:

Deputy Assistant Secretary of the Navy (Environment)
Office of Assistant General Counsel (Installations & Environment)
Commander, Naval Installations Command (N46)
Commander, Navy Region Northwest (N40)
Commander, Naval Facilities Engineering Command Northwest (N45)

This page is intentionally blank.

REPLY TO
ATTENTION OF

DEPARTMENT OF THE ARMY
SEATTLE DISTRICT, CORPS OF ENGINEERS
P.O. BOX 3755
SEATTLE, WASHINGTON 98124-3755

JUL 26 2013

Regulatory Branch

Captain Peter M. Dawson
Naval Base Kitsap
120 South Dewey Street
Bremerton, Washington 98314-5020

Reference: NWS-2013-243
U.S. Navy – Bangor
(Land Water Interface)

NWS-2013-244
U.S. Navy – Bangor
(Service Pier Extension)

Dear Captain Dawson:

The U.S. Army Corps of Engineers (Corps), Seattle District, Regulatory Branch, agrees to participate as a cooperating agency in the preparation of the Environmental Impact Statement (EIS) for the proposed Land-Water Interface project and Service Pier Extension project at Naval Base Kitsap – Bangor. The Land-Water Interface and Service Pier Extension are not connected projects, but are related due to their proximity, anticipated timing of construction, and potential to affect similar environmental resources. Therefore, both proposals are being analyzed in one EIS. Since these projects have independent utility, the Corps will process each permit application for a separate Department of the Army permit. We ask that you send two copies of documents so that a copy could be placed in each permit application's respective administrative record.

After an application is received from you, the Corps would likely process it as an Individual Permit under Section 10 of the Rivers and Harbors Act of 1899. If either action would result in a discharge of dredged or fill material within the mean higher high water line, the action would also be processed under Section 404 of the Clean Water Act. We will incorporate certain parts of the EIS by reference in our application review process.

As a cooperating agency, the Corps would support the Navy by:

- a. Attending public scoping meetings.

- 2 -

- b. Providing timely comments during the scoping period and timely review and comments on working drafts of the Environmental Impact Statement documents.
- c. Assisting the Navy in determining appropriate avoidance, minimization, and/or mitigation measures to incorporate into the proposed action.
- d. Responding to Navy requests for information in a timely manner.
- e. Participating, as necessary, in meetings hosted by the Navy to discuss issues related to waters of the U.S.
- f. Adhering to the overall schedule set by the Navy.

A copy of this letter will be furnished to Mr. Gregory Leicht, Naval Base Kitsap, 7001 Finback Circle, Room E-300, Silverdale, Washington 98315 and Mr. Thomas Dildine, Naval Facilities Engineering Command Northwest, 1101 Tautog Circle, Silverdale, Washington 98315. Ms. Karen Urelius, Project Manager, will be the Corps' point of contact for this project. You can reach her at (206) 764-3482, or via email at karen.m.urelius@usace.army.mil.

Sincerely,



 Bruce A. Estok
Colonel, Corps of Engineers
District Engineer

Tribes and Cultural Resources

This page is intentionally blank.



DEPARTMENT OF THE NAVY
NAVAL BASE KITSAP
120 SOUTH DEWEY ST
BREMERTON, WA 98314-5020

5090
Ser PRB4/00647
17 Aug 11

Allyson Brooks, PhD
State Historic Preservation Officer
Department of Archaeology and Historic Preservation
P.O. Box 48343
Olympia, WA 98504-8343

Dear Dr. Brooks:

SUBJECT: REQUEST FOR CONCURRENCE WITH AREA OF POTENTIAL EFFECT
AND A DETERMINATION OF NO HISTORIC PROPERTIES Affected
BY GEOTECHNICAL INVESTIGATIONS FOR THE LAND-WATER
INTERFACE PROJECT AT NAVAL BASE KITSAP BANGOR

The U.S. Navy proposes to perform geotechnical testing at two locations on the shoreline of Naval Base Kitsap Bangor, Kitsap County, Washington (Enclosure 1). The purpose of the study is to provide data for design of a Land-Water Interface between existing waterborne security barriers and the Waterfront Enclave fence (DAHP Log. No. 051209-25-USN). The Navy will initiate separate consultation on the Land-Water Interface project, but the proposed geotechnical testing is required to provide information to support the project design. In accordance with Section 106 of the National Historic Preservation Act of 1966, as amended (16 U.S.C. 470f), and its implementing regulation, 36 CFR 800, the Navy is submitting a determination of effects to historic properties from this proposed undertaking.

The Navy proposes to conduct geotechnical testing with eight bore holes at two locations (three at the northern area and five at the southern) (Enclosures 2 and 3). The testing will be conducted from a barge and two steel spuds will be deployed to fix the barge's position at each designated boring location. Sediment samples will be collected by a mud-rotary drill attached to a track mounted drill rig. A 6-inch casing will be placed using an impact hammer to a depth of 2 to 5 feet into the sediment, to prevent turbidity from entering surface waters during drilling activities. Once the casing is in place, a 5-inch rotary tricone drill bit will be used to drill within the confines of the casing.

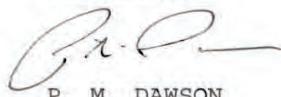
SUBJECT: REQUEST FOR CONCURRENCE WITH AREA OF POTENTIAL EFFECT
AND A DETERMINATION OF NO HISTORIC PROPERTIES Affected
BY GEOTECHNICAL INVESTIGATIONS FOR THE LAND-WATER
INTERFACE PROJECT AT NAVAL BASE KITSAP BANGOR

The area of potential effect (APE) for this proposed undertaking comprises the drill sites for the eight 6-inch diameter casings and 5-inch bore holes and the surface disturbance caused the placement of the steel spuds. The bore holes will extend approximately 60 feet below the mudline.

There are no recorded submerged historic properties, downed aircraft, shipwrecks, traditional fishing features or other structures in the offshore area. There are, however, three prehistoric shell middens located along the waterfront at Naval Base Kitsap at Bangor (45KP106, the Floral Point Shell Midden, 45KP107, the Amberjack Road Shell Midden, and 45KP108, the Carlson Spit Shell Midden) but these are well removed from the APE. Owing to the small volume of disturbance a low probability for the presence of intact archaeological deposits or features in the APE, the Navy has determined a historic inventory survey is not warranted.

The Navy requests your concurrence on our determination of the APE and *No Historic Properties Affected* from the geotechnical study for the Land-Water Interface project. If you require further information or have any questions, please contact Bill Kalina at (360) 396-5353 or william.kalina@navy.mil.

Sincerely,



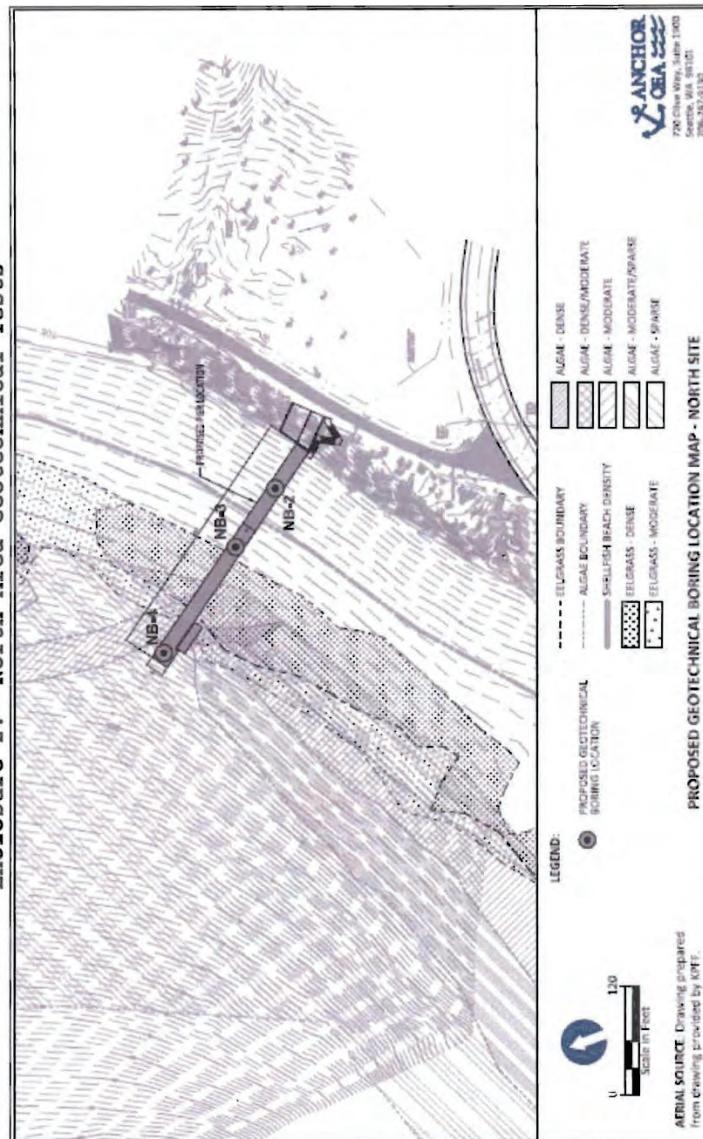
P. M. DAWSON
Captain, U.S. Navy
Commanding Officer

Enclosures: 1. Project Location
2. North Area Geotechnical Tests
3. Southern Area Geotechnical Tests

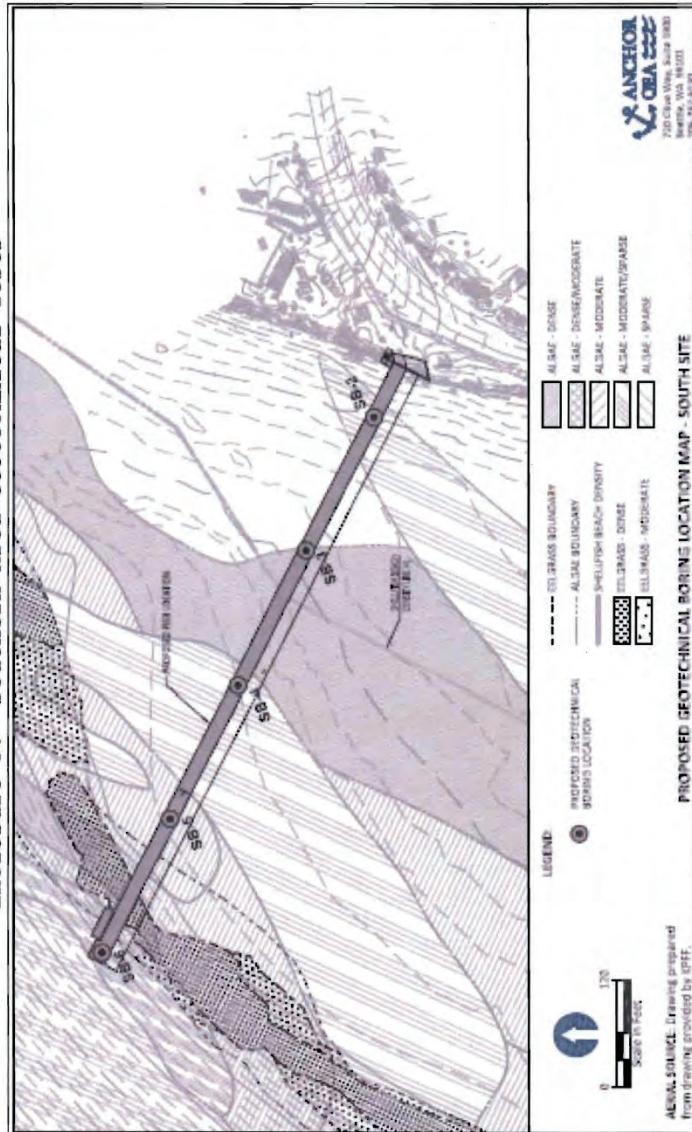
Enclosure 1. Project Location Map



Enclosure 2. North Area Geotechnical Tests



Enclosure 3. Southern Area Geotechnical Tests



This page is intentionally blank.



DEPARTMENT OF THE NAVY
NAVAL BASE KITSAP
120 SOUTH DEWEY ST
BREMERTON, WA 98314-5020

5090
Ser PRB4/00118
30 Jan 13

Jamestown S'Klallam Tribe
The Honorable W. Ron Allen
1033 Old Blyn Hwy
Sequim, WA 98382

Dear Chairman Allen:

SUBJECT: LAND-WATER INTERFACE AND SERVICE PIER EXTENSION ON
NAVAL BASE KITSAP BANGOR, ENVIRONMENTAL IMPACT
STATEMENT

During August 2012 in government-to-government consultations the Navy briefed you on two proposed projects, the Land Water Interface and the Service Pier Extension. The Navy's planning for these projects has progressed and the Navy is preparing an Environmental Impact Statement (EIS) to evaluate the potential environmental impacts from the Navy's proposed construction and operation of new security structures, relocation of submarines and extension of an existing pier on the Naval Base (NAVBASE) Kitsap Bangor waterfront.

Pursuant to the Navy's policy for American Indian/Alaska Native tribal government-to-government consultation, I would like to extend the opportunity for you to review the proposed actions and to evaluate whether you believe there would be a potential to significantly affect tribal treaty harvest rights or cultural resources as a result of the implementation of the proposed actions.

The Navy proposes two projects on the NAVBASE Kitsap Bangor waterfront. The purpose of the proposed actions is to: 1) comply with Department of Defense directives to protect OHIO Class ballistic missile submarines from increased and evolving threats and to prevent the seizure, damage or destruction of military assets and 2) eliminate deployment constraints and improve maintenance of the SEAWOLF Class submarines.

The proposed actions include: 1) a Land-Water Interface and Port Security Barrier modifications and 2) a Service Pier Extension. The Land-Water Interface and Service Pier Extension are not connected projects, but are related due to their

SUBJECT: LAND-WATER INTERFACE AND SERVICE PIER EXTENSION ON
NAVAL BASE KITSAP BANGOR, ENVIRONMENTAL IMPACT
STATEMENT

proximity, anticipated timing of construction and potential to affect similar environmental resources. The Navy will therefore analyze these separate actions in the Land-Water Interface and Service Pier Extension on NAVBASE Kitsap Bangor EIS.

The Navy proposes the following actions:

Land-Water Interface:

- Construct two pile-supported piers or modify/lengthen the existing Port Security Barriers across the intertidal zone to enclose the Waterfront Restricted Area on NAVBASE Kitsap Bangor

Service Pier Extension:

- Relocate two SEAWOLF Class submarines from NAVBASE Kitsap Bremerton to NAVBASE Kitsap Bangor
- Extend the existing Bangor waterfront Service Pier
- Construct associated facilities and a parking lot

The proposed Land-Water Interface and Port Security Barriers are needed to enhance security within the Waterfront Restricted Area on NAVBASE Kitsap Bangor. Construction of the proposed Service Pier Extension and support facilities is needed to remove restrictions on navigating SEAWOLF Class submarines through Rich Passage under certain tidal conditions; improve long-term operational effectiveness for the proposed three SEAWOLF Class submarines at NAVASE Kitsap Bangor; provide berthing and logistical support at the Navy's submarine research, development, test and evaluation hub, located on NAVBASE Kitsap Bangor; and improve submarine crew training and readiness through co-location of SEAWOLF Class submarines and crew with command functions at the NAVBASE Kitsap Bangor submarine training center.

The EIS will include an analysis of potential impacts on a range of environmental resources including, but not limited to: water quality and littoral drift, marine vegetation and invertebrates, fish, marine mammals, marine birds, terrestrial biological resources, geology, soils and water resources, land use and recreation, acoustic environment, aesthetics and visual quality, socioeconomics, environmental justice and protection of children, cultural resources, American Indian traditional resources, traffic, air quality and public safety. Your input

SUBJECT: LAND-WATER INTERFACE AND SERVICE PIER EXTENSION ON
NAVAL BASE KITSAP BANGOR, ENVIRONMENTAL IMPACT
STATEMENT

in identifying specific issues and concerns that should be assessed in these areas, and any additional areas, is important to the process.

The Navy is holding two open house information sessions to support an early and open public process for determining the scope of concerns to be addressed and identifying potentially significant concerns related to the proposed actions. You may arrive at any time from 5 p.m. to 8 p.m. during each open house information session. There will not be a presentation or formal oral comment period; however, a digital voice recorder will be available for oral comments. Navy representatives will be available to discuss the projects and answer questions. You will also have an opportunity to submit comments on environmental concerns and potential alternatives to be addressed in the Draft EIS. Your input will be used to help identify potentially significant concerns to be analyzed.

The open house information sessions will be held from 5 p.m. to 8 p.m. at the following locations:

Date: **Wednesday, Feb. 20, 2013**
Location: Chimacum High School Commons
91 W. Valley Road
Chimacum, WA 98325

Date: **Thursday, Feb. 21, 2013**
Location: North Kitsap High School Commons
1780 NE Hostmark St.
Poulsbo, WA 98370

Regardless of whether you are able to participate in an open house information session, you may send written comments to the following address:

Naval Facilities Engineering Command Northwest
Attention: LWI/SPE EIS Team
1101 Tautog Circle, Suite 203
Silverdale, WA 98315-1101

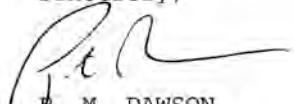
SUBJECT: LAND-WATER INTERFACE AND SERVICE PIER EXTENSION ON
NAVAL BASE KITSAP BANGOR, ENVIRONMENTAL IMPACT
STATEMENT

You may also submit comments online at www.nbkeis.com/lwi.
All comments must be received by **Sunday, March 17, 2013**, to be
considered in the development of the Draft EIS.

For more information about the EIS, please visit the project
website at www.nbkeis.com/lwi.

While the Navy has already briefed you on the proposed projects, we are interested in discussing these projects with you further as details of the projects emerge. I am aware of the significant value of natural and cultural resources of your Tribe within the EIS Study Area, and I look forward to discussing your questions and concerns about the proposed projects. I am available to meet with you at your convenience. Please feel free to contact me directly at (360) 627-4000 or peter.m.dawson@navy.mil, or contact my Environmental Director, Mr. Greg Leicht, at 360-315-5411 or gregory.leicht@navy.mil.

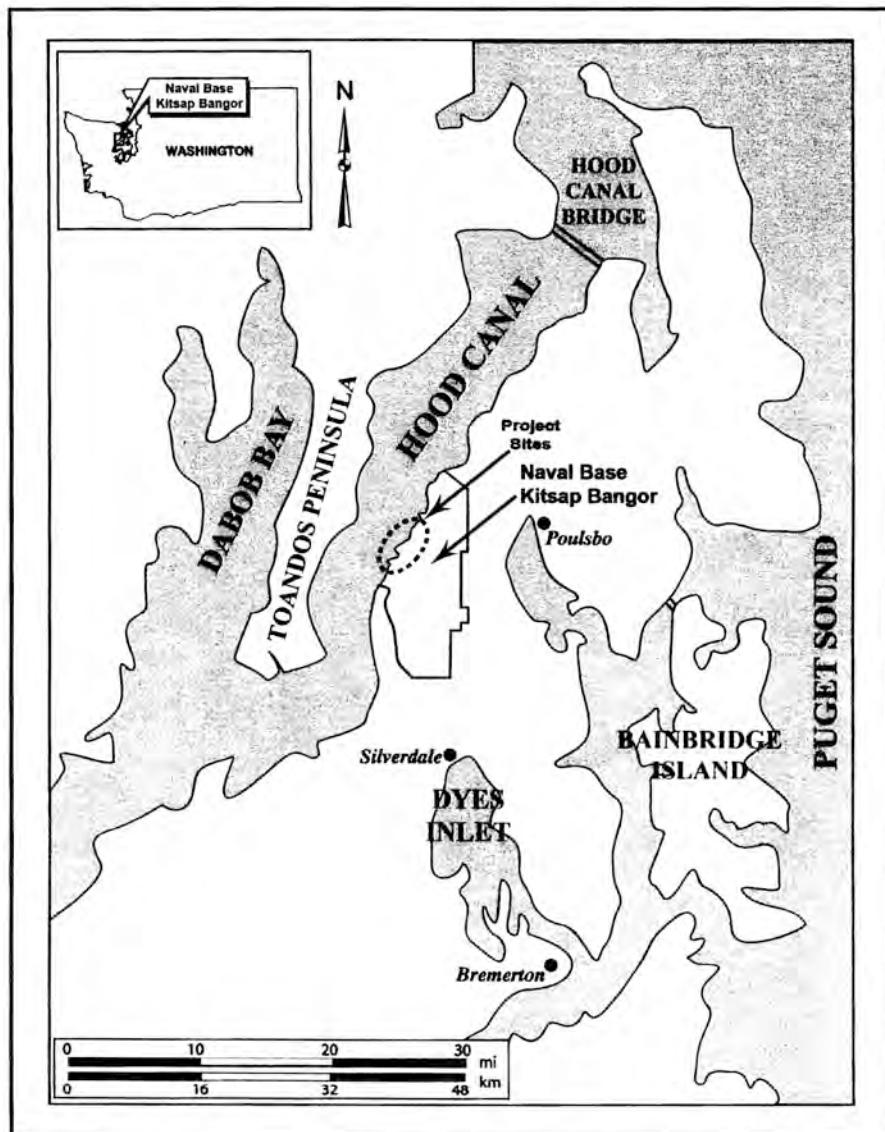
Sincerely,



P. M. DAWSON
Captain, U. S. Navy
Commanding Officer

Enclosure: 1. Site location map for Naval Base Kitsap Bangor

Enclosure 1: Site location map for
Naval Base Kitsap Bangor



This page is intentionally blank.



DEPARTMENT OF THE NAVY
NAVAL BASE KITSAP
120 SOUTH DEWEY ST
BREMERTON, WA 98314-5020

5090
Ser PRB4/00119
30 Jan 13

The Lower Elwha Klallam Tribe
The Honorable Frances Charles
2851 Lower Elwha Road
Port Angeles WA 98362

Dear Chairwoman Charles:

SUBJECT: LAND-WATER INTERFACE AND SERVICE PIER EXTENSION ON
NAVAL BASE KITSAP BANGOR, ENVIRONMENTAL IMPACT
STATEMENT

During August 2012 in government-to-government consultations the Navy briefed you on two proposed projects, the Land Water Interface and the Service Pier Extension. The Navy's planning for these projects has progressed and the Navy is preparing an Environmental Impact Statement (EIS) to evaluate the potential environmental impacts from the Navy's proposed construction and operation of new security structures, relocation of submarines and extension of an existing pier on the Naval Base (NAVBASE) Kitsap Bangor waterfront.

Pursuant to the Navy's policy for American Indian/Alaska Native tribal government-to-government consultation, I would like to extend the opportunity for you to review the proposed actions and to evaluate whether you believe there would be a potential to significantly affect tribal treaty harvest rights or cultural resources as a result of the implementation of the proposed actions.

The Navy proposes two projects on the NAVBASE Kitsap Bangor waterfront. The purpose of the proposed actions is to: 1) comply with Department of Defense directives to protect OHIO Class ballistic missile submarines from increased and evolving threats and to prevent the seizure, damage or destruction of military assets and 2) eliminate deployment constraints and improve maintenance of the SEAWOLF Class submarines.

The proposed actions include: 1) a Land-Water Interface and Port Security Barrier modifications and 2) a Service Pier Extension. The Land-Water Interface and Service Pier Extension are not connected projects, but are related due to their

SUBJECT: LAND-WATER INTERFACE AND SERVICE PIER EXTENSION ON
NAVAL BASE KITSAP BANGOR, ENVIRONMENTAL IMPACT
STATEMENT

proximity, anticipated timing of construction and potential to affect similar environmental resources. The Navy will therefore analyze these separate actions in the Land-Water Interface and Service Pier Extension on NAVBASE Kitsap Bangor EIS.

The Navy proposes the following actions:

Land-Water Interface:

- Construct two pile-supported piers or modify/lengthen the existing Port Security Barriers across the intertidal zone to enclose the Waterfront Restricted Area on NAVBASE Kitsap Bangor

Service Pier Extension:

- Relocate two SEAWOLF Class submarines from NAVBASE Kitsap Bremerton to NAVBASE Kitsap Bangor
- Extend the existing Bangor waterfront Service Pier
- Construct associated facilities and a parking lot

The proposed Land-Water Interface and Port Security Barriers are needed to enhance security within the Waterfront Restricted Area on NAVBASE Kitsap Bangor. Construction of the proposed Service Pier Extension and support facilities is needed to remove restrictions on navigating SEAWOLF Class submarines through Rich Passage under certain tidal conditions; improve long-term operational effectiveness for the proposed three SEAWOLF Class submarines at NAVASE Kitsap Bangor; provide berthing and logistical support at the Navy's submarine research, development, test and evaluation hub, located on NAVBASE Kitsap Bangor; and improve submarine crew training and readiness through co-location of SEAWOLF Class submarines and crew with command functions at the NAVBASE Kitsap Bangor submarine training center.

The EIS will include an analysis of potential impacts on a range of environmental resources including, but not limited to: water quality and littoral drift, marine vegetation and invertebrates, fish, marine mammals, marine birds, terrestrial biological resources, geology, soils and water resources, land use and recreation, acoustic environment, aesthetics and visual quality, socioeconomics, environmental justice and protection of children, cultural resources, American Indian traditional resources, traffic, air quality and public safety. Your input

SUBJECT: LAND-WATER INTERFACE AND SERVICE PIER EXTENSION ON
NAVAL BASE KITSAP BANGOR, ENVIRONMENTAL IMPACT
STATEMENT

in identifying specific issues and concerns that should be assessed in these areas, and any additional areas, is important to the process.

The Navy is holding two open house information sessions to support an early and open public process for determining the scope of concerns to be addressed and identifying potentially significant concerns related to the proposed actions. You may arrive at any time from 5 p.m. to 8 p.m. during each open house information session. There will not be a presentation or formal oral comment period; however, a digital voice recorder will be available for oral comments. Navy representatives will be available to discuss the projects and answer questions. You will also have an opportunity to submit comments on environmental concerns and potential alternatives to be addressed in the Draft EIS. Your input will be used to help identify potentially significant concerns to be analyzed.

The open house information sessions will be held from 5 p.m. to 8 p.m. at the following locations:

Date: **Wednesday, Feb. 20, 2013**
Location: Chimacum High School Commons
91 W. Valley Road
Chimacum, WA 98325

Date: **Thursday, Feb. 21, 2013**
Location: North Kitsap High School Commons
1780 NE Hostmark St.
Poulsbo, WA 98370

Regardless of whether you are able to participate in an open house information session, you may send written comments to the following address:

Naval Facilities Engineering Command Northwest
Attention: LWI/SPE EIS Team
1101 Tautog Circle, Suite 203
Silverdale, WA 98315-1101

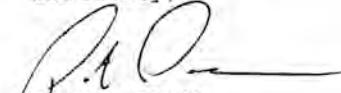
SUBJECT: LAND-WATER INTERFACE AND SERVICE PIER EXTENSION ON
NAVAL BASE KITSAP BANGOR, ENVIRONMENTAL IMPACT
STATEMENT

You may also submit comments online at www.nbkeis.com/lwi.
All comments must be received by **Sunday, March 17, 2013**, to be
considered in the development of the Draft EIS.

For more information about the EIS, please visit the project
website at www.nbkeis.com/lwi.

While the Navy has already briefed you on the proposed
projects, we are interested in discussing these projects with
you further as details of the projects emerge. I am aware of the
significant value of natural and cultural resources of your
Tribe within the EIS Study Area, and I look forward to
discussing your questions and concerns about the proposed
projects. I am available to meet with you at your convenience.
Please feel free to contact me directly at (360) 627-4000 or
peter.m.dawson@navy.mil, or contact my Environmental Director,
Mr. Greg Leicht, at 360-315-5411 or gregory.leicht@navy.mil.

Sincerely,



P. M. DAWSON
Captain, U. S. Navy
Commanding Officer

Enclosure: 1. Site location map for Naval Base Kitsap Bangor



DEPARTMENT OF THE NAVY
NAVAL BASE KITSAP
120 SOUTH DEWEY ST
BREMERTON, WA 98314-5020

5090
Ser PRB4/00117
30 Jan 13

The Honorable Jeremy Sullivan
Chairman, Port Gamble S'Klallam Tribe
31912 Little Boston Road NE
Kingston, WA 98346

Dear Chairman Sullivan:

SUBJECT: LAND-WATER INTERFACE AND SERVICE PIER EXTENSION ON
NAVAL BASE KITSAP BANGOR, ENVIRONMENTAL IMPACT
STATEMENT

During August 2012 in government-to-government consultations the Navy briefed you on two proposed projects, the Land Water Interface and the Service Pier Extension. The Navy's planning for these projects has progressed and the Navy is preparing an Environmental Impact Statement (EIS) to evaluate the potential environmental impacts from the Navy's proposed construction and operation of new security structures, relocation of submarines and extension of an existing pier on the Naval Base (NAVBASE) Kitsap Bangor waterfront.

Pursuant to the Navy's policy for American Indian/Alaska Native tribal government-to-government consultation, I would like to extend the opportunity for you to review the proposed actions and to evaluate whether you believe there would be a potential to significantly affect tribal treaty harvest rights or cultural resources as a result of the implementation of the proposed actions.

The Navy proposes two projects on the NAVBASE Kitsap Bangor waterfront. The purpose of the proposed actions is to: 1) comply with Department of Defense directives to protect OHIO Class ballistic missile submarines from increased and evolving threats and to prevent the seizure, damage or destruction of military assets and 2) eliminate deployment constraints and improve maintenance of the SEAWOLF Class submarines.

The proposed actions include: 1) a Land-Water Interface and Port Security Barrier modifications and 2) a Service Pier Extension. The Land-Water Interface and Service Pier Extension are not connected projects, but are related due to their

SUBJECT: LAND-WATER INTERFACE AND SERVICE PIER EXTENSION ON
NAVAL BASE KITSAP BANGOR, ENVIRONMENTAL IMPACT
STATEMENT

proximity, anticipated timing of construction and potential to affect similar environmental resources. The Navy will therefore analyze these separate actions in the Land-Water Interface and Service Pier Extension on NAVBASE Kitsap Bangor EIS.

The Navy proposes the following actions:

Land-Water Interface:

- Construct two pile-supported piers or modify/lengthen the existing Port Security Barriers across the intertidal zone to enclose the Waterfront Restricted Area on NAVBASE Kitsap Bangor

Service Pier Extension:

- Relocate two SEAWOLF Class submarines from NAVBASE Kitsap Bremerton to NAVBASE Kitsap Bangor
- Extend the existing Bangor waterfront Service Pier
- Construct associated facilities and a parking lot

The proposed Land-Water Interface and Port Security Barriers are needed to enhance security within the Waterfront Restricted Area on NAVBASE Kitsap Bangor. Construction of the proposed Service Pier Extension and support facilities is needed to remove restrictions on navigating SEAWOLF Class submarines through Rich Passage under certain tidal conditions; improve long-term operational effectiveness for the proposed three SEAWOLF Class submarines at NAVASE Kitsap Bangor; provide berthing and logistical support at the Navy's submarine research, development, test and evaluation hub, located on NAVBASE Kitsap Bangor; and improve submarine crew training and readiness through co-location of SEAWOLF Class submarines and crew with command functions at the NAVBASE Kitsap Bangor submarine training center.

The EIS will include an analysis of potential impacts on a range of environmental resources including, but not limited to: water quality and littoral drift, marine vegetation and invertebrates, fish, marine mammals, marine birds, terrestrial biological resources, geology, soils and water resources, land use and recreation, acoustic environment, aesthetics and visual quality, socioeconomics, environmental justice and protection of children, cultural resources, American Indian traditional resources, traffic, air quality and public safety. Your input

SUBJECT: LAND-WATER INTERFACE AND SERVICE PIER EXTENSION ON
NAVAL BASE KITSAP BANGOR, ENVIRONMENTAL IMPACT
STATEMENT

in identifying specific issues and concerns that should be assessed in these areas, and any additional areas, is important to the process.

The Navy is holding two open house information sessions to support an early and open public process for determining the scope of concerns to be addressed and identifying potentially significant concerns related to the proposed actions. You may arrive at any time from 5 p.m. to 8 p.m. during each open house information session. There will not be a presentation or formal oral comment period; however, a digital voice recorder will be available for oral comments. Navy representatives will be available to discuss the projects and answer questions. You will also have an opportunity to submit comments on environmental concerns and potential alternatives to be addressed in the Draft EIS. Your input will be used to help identify potentially significant concerns to be analyzed.

The open house information sessions will be held from 5 p.m. to 8 p.m. at the following locations:

Date: **Wednesday, Feb. 20, 2013**
Location: Chimacum High School Commons
91 W. Valley Road
Chimacum, WA 98325

Date: **Thursday, Feb. 21, 2013**
Location: North Kitsap High School Commons
1780 NE Hostmark St.
Poulsbo, WA 98370

Regardless of whether you are able to participate in an open house information session, you may send written comments to the following address:

Naval Facilities Engineering Command Northwest
Attention: LWI/SPE EIS Team
1101 Tautog Circle, Suite 203
Silverdale, WA 98315-1101

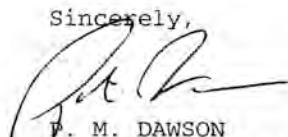
SUBJECT: LAND-WATER INTERFACE AND SERVICE PIER EXTENSION ON
NAVAL BASE KITSAP BANGOR, ENVIRONMENTAL IMPACT
STATEMENT

You may also submit comments online at www.nbkeis.com/lwi.
All comments must be received by **Sunday, March 17, 2013**, to be
considered in the development of the Draft EIS.

For more information about the EIS, please visit the project
website at www.nbkeis.com/lwi.

While the Navy has already briefed you on the proposed projects, we are interested in discussing these projects with you further as details of the projects emerge. I am aware of the significant value of natural and cultural resources of your Tribe within the EIS Study Area, and I look forward to discussing your questions and concerns about the proposed projects. I am available to meet with you at your convenience. Please feel free to contact me directly at (360) 627-4000 or peter.m.dawson@navy.mil, or contact my Environmental Director, Mr. Greg Leicht, at 360-315-5411 or gregory.leicht@navy.mil.

Sincerely,



P. M. DAWSON
Captain, U. S. Navy
Commanding Officer

Enclosure: 1. Site location map for Naval Base Kitsap Bangor



DEPARTMENT OF THE NAVY
NAVAL BASE KITSAP
120 SOUTH DEWEY ST
BREMERTON, WA 98314-5020

5090
Ser PRB4/00120
30 Jan 13

The Skokomish Tribe
The Honorable Guy Miller
North 80 Tribal Center Road
Skokomish WA 98584

Dear Chairman Miller:

SUBJECT: LAND-WATER INTERFACE AND SERVICE PIER EXTENSION ON
NAVAL BASE KITSAP BANGOR, ENVIRONMENTAL IMPACT
STATEMENT

During August 2012 in government-to-government consultations the Navy briefed you on two proposed projects, the Land Water Interface and the Service Pier Extension. The Navy's planning for these projects has progressed and the Navy is preparing an Environmental Impact Statement (EIS) to evaluate the potential environmental impacts from the Navy's proposed construction and operation of new security structures, relocation of submarines and extension of an existing pier on the Naval Base (NAVBASE) Kitsap Bangor waterfront.

Pursuant to the Navy's policy for American Indian/Alaska Native tribal government-to-government consultation, I would like to extend the opportunity for you to review the proposed actions and to evaluate whether you believe there would be a potential to significantly affect tribal treaty harvest rights or cultural resources as a result of the implementation of the proposed actions.

The Navy proposes two projects on the NAVBASE Kitsap Bangor waterfront. The purpose of the proposed actions is to: 1) comply with Department of Defense directives to protect OHIO Class ballistic missile submarines from increased and evolving threats and to prevent the seizure, damage or destruction of military assets and 2) eliminate deployment constraints and improve maintenance of the SEAWOLF Class submarines.

The proposed actions include: 1) a Land-Water Interface and Port Security Barrier modifications and 2) a Service Pier Extension. The Land-Water Interface and Service Pier Extension are not connected projects, but are related due to their

SUBJECT: LAND-WATER INTERFACE AND SERVICE PIER EXTENSION ON NAVAL BASE KITSAP BANGOR, ENVIRONMENTAL IMPACT STATEMENT

proximity, anticipated timing of construction and potential to affect similar environmental resources. The Navy will therefore analyze these separate actions in the Land-Water Interface and Service Pier Extension on NAVBASE Kitsap Bangor EIS.

The Navy proposes the following actions:

Land-Water Interface:

- Construct two pile-supported piers or modify/lengthen the existing Port Security Barriers across the intertidal zone to enclose the Waterfront Restricted Area on NAVBASE Kitsap Bangor

Service Pier Extension:

- Relocate two SEAWOLF Class submarines from NAVBASE Kitsap Bremerton to NAVBASE Kitsap Bangor
- Extend the existing Bangor waterfront Service Pier
- Construct associated facilities and a parking lot

The proposed Land-Water Interface and Port Security Barriers are needed to enhance security within the Waterfront Restricted Area on NAVBASE Kitsap Bangor. Construction of the proposed Service Pier Extension and support facilities is needed to remove restrictions on navigating SEAWOLF Class submarines through Rich Passage under certain tidal conditions; improve long-term operational effectiveness for the proposed three SEAWOLF Class submarines at NAVASE Kitsap Bangor; provide berthing and logistical support at the Navy's submarine research, development, test and evaluation hub, located on NAVBASE Kitsap Bangor; and improve submarine crew training and readiness through co-location of SEAWOLF Class submarines and crew with command functions at the NAVBASE Kitsap Bangor submarine training center.

The EIS will include an analysis of potential impacts on a range of environmental resources including, but not limited to: water quality and littoral drift, marine vegetation and invertebrates, fish, marine mammals, marine birds, terrestrial biological resources, geology, soils and water resources, land use and recreation, acoustic environment, aesthetics and visual quality, socioeconomics, environmental justice and protection of children, cultural resources, American Indian traditional resources, traffic, air quality and public safety. Your input

SUBJECT: LAND-WATER INTERFACE AND SERVICE PIER EXTENSION ON
NAVAL BASE KITSAP BANGOR, ENVIRONMENTAL IMPACT
STATEMENT

in identifying specific issues and concerns that should be assessed in these areas, and any additional areas, is important to the process.

The Navy is holding two open house information sessions to support an early and open public process for determining the scope of concerns to be addressed and identifying potentially significant concerns related to the proposed actions. You may arrive at any time from 5 p.m. to 8 p.m. during each open house information session. There will not be a presentation or formal oral comment period; however, a digital voice recorder will be available for oral comments. Navy representatives will be available to discuss the projects and answer questions. You will also have an opportunity to submit comments on environmental concerns and potential alternatives to be addressed in the Draft EIS. Your input will be used to help identify potentially significant concerns to be analyzed.

The open house information sessions will be held from 5 p.m. to 8 p.m. at the following locations:

Date: **Wednesday, Feb. 20, 2013**
Location: Chimacum High School Commons
91 W. Valley Road
Chimacum, WA 98325

Date: **Thursday, Feb. 21, 2013**
Location: North Kitsap High School Commons
1780 NE Hostmark St.
Poulsbo, WA 98370

Regardless of whether you are able to participate in an open house information session, you may send written comments to the following address:

Naval Facilities Engineering Command Northwest
Attention: LWI/SPE EIS Team
1101 Tautog Circle, Suite 203
Silverdale, WA 98315-1101

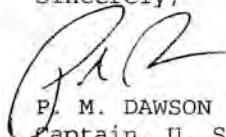
SUBJECT: LAND-WATER INTERFACE AND SERVICE PIER EXTENSION ON
NAVAL BASE KITSAP BANGOR, ENVIRONMENTAL IMPACT
STATEMENT

You may also submit comments online at www.nbkeis.com/lwi.
All comments must be received by **Sunday, March 17, 2013**, to be
considered in the development of the Draft EIS.

For more information about the EIS, please visit the project
website at www.nbkeis.com/lwi.

While the Navy has already briefed you on the proposed projects, we are interested in discussing these projects with you further as details of the projects emerge. I am aware of the significant value of natural and cultural resources of your Tribe within the EIS Study Area, and I look forward to discussing your questions and concerns about the proposed projects. I am available to meet with you at your convenience. Please feel free to contact me directly at (360) 627-4000 or peter.m.dawson@navy.mil, or contact my Environmental Director, Mr. Greg Leicht, at 360-315-5411 or gregory.leicht@navy.mil.

Sincerely,



P. M. DAWSON
Captain, U. S. Navy
Commanding Officer

Enclosure: 1. Site location map for Naval Base Kitsap Bangor



DEPARTMENT OF THE NAVY
NAVAL BASE KITSAP
120 SOUTH DEWEY ST
BREMERTON, WA 98314-5020

5090
Ser PRB4/00116
30 Jan 13

The Honorable Leonard Forsman
The Suquamish Tribe
PO Box 498
Suquamish, WA 98392

Dear Chairman Forsman:

SUBJECT: LAND-WATER INTERFACE AND SERVICE PIER EXTENSION ON
NAVAL BASE KITSAP BANGOR, ENVIRONMENTAL IMPACT
STATEMENT

During October 2012 in government-to-government consultations the Navy briefed you on two proposed projects, the Land Water Interface and the Service Pier Extension. The Navy's planning for these projects has progressed and the Navy is preparing an Environmental Impact Statement (EIS) to evaluate the potential environmental impacts from the Navy's proposed construction and operation of new security structures, relocation of submarines and extension of an existing pier on the Naval Base (NAVBASE) Kitsap Bangor waterfront.

Pursuant to the Navy's policy for American Indian/Alaska Native tribal government-to-government consultation, I would like to extend the opportunity for you to review the proposed actions and to evaluate whether you believe there would be a potential to significantly affect tribal treaty harvest rights or cultural resources as a result of the implementation of the proposed actions.

The Navy proposes two projects on the NAVBASE Kitsap Bangor waterfront. The purpose of the proposed actions is to: 1) comply with Department of Defense directives to protect OHIO Class ballistic missile submarines from increased and evolving threats and to prevent the seizure, damage or destruction of military assets and 2) eliminate deployment constraints and improve maintenance of the SEAWOLF Class submarines.

The proposed actions include: 1) a Land-Water Interface and Port Security Barrier modifications and 2) a Service Pier Extension. The Land-Water Interface and Service Pier Extension are not connected projects, but are related due to their

SUBJECT: LAND-WATER INTERFACE AND SERVICE PIER EXTENSION ON
NAVAL BASE KITSAP BANGOR, ENVIRONMENTAL IMPACT
STATEMENT

proximity, anticipated timing of construction and potential to affect similar environmental resources. The Navy will therefore analyze these separate actions in the Land-Water Interface and Service Pier Extension on NAVBASE Kitsap Bangor EIS.

The Navy proposes the following actions:

Land-Water Interface:

- Construct two pile-supported piers or modify/lengthen the existing Port Security Barriers across the intertidal zone to enclose the Waterfront Restricted Area on NAVBASE Kitsap Bangor

Service Pier Extension:

- Relocate two SEAWOLF Class submarines from NAVBASE Kitsap Bremerton to NAVBASE Kitsap Bangor
- Extend the existing Bangor waterfront Service Pier
- Construct associated facilities and a parking lot

The proposed Land-Water Interface and Port Security Barriers are needed to enhance security within the Waterfront Restricted Area on NAVBASE Kitsap Bangor. Construction of the proposed Service Pier Extension and support facilities is needed to remove restrictions on navigating SEAWOLF Class submarines through Rich Passage under certain tidal conditions; improve long-term operational effectiveness for the proposed three SEAWOLF Class submarines at NAVASE Kitsap Bangor; provide berthing and logistical support at the Navy's submarine research, development, test and evaluation hub, located on NAVBASE Kitsap Bangor; and improve submarine crew training and readiness through co-location of SEAWOLF Class submarines and crew with command functions at the NAVBASE Kitsap Bangor submarine training center.

The EIS will include an analysis of potential impacts on a range of environmental resources including, but not limited to: water quality and littoral drift, marine vegetation and invertebrates, fish, marine mammals, marine birds, terrestrial biological resources, geology, soils and water resources, land use and recreation, acoustic environment, aesthetics and visual quality, socioeconomics, environmental justice and protection of children, cultural resources, American Indian traditional resources, traffic, air quality and public safety. Your input

SUBJECT: LAND-WATER INTERFACE AND SERVICE PIER EXTENSION ON
NAVAL BASE KITSAP BANGOR, ENVIRONMENTAL IMPACT
STATEMENT

in identifying specific issues and concerns that should be assessed in these areas, and any additional areas, is important to the process.

The Navy is holding two open house information sessions to support an early and open public process for determining the scope of concerns to be addressed and identifying potentially significant concerns related to the proposed actions. You may arrive at any time from 5 p.m. to 8 p.m. during each open house information session. There will not be a presentation or formal oral comment period; however, a digital voice recorder will be available for oral comments. Navy representatives will be available to discuss the projects and answer questions. You will also have an opportunity to submit comments on environmental concerns and potential alternatives to be addressed in the Draft EIS. Your input will be used to help identify potentially significant concerns to be analyzed.

The open house information sessions will be held from 5 p.m. to 8 p.m. at the following locations:

Date: **Wednesday, Feb. 20, 2013**
Location: Chimacum High School Commons
91 W. Valley Road
Chimacum, WA 98325

Date: **Thursday, Feb. 21, 2013**
Location: North Kitsap High School Commons
1780 NE Hostmark St.,
Poulsbo, WA 98370

Regardless of whether you are able to participate in an open house information session, you may send written comments to the following address:

Naval Facilities Engineering Command Northwest
Attention: LWI/SPE EIS Team
1101 Tautog Circle, Suite 203
Silverdale, WA 98315-1101

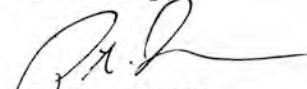
SUBJECT: LAND-WATER INTERFACE AND SERVICE PIER EXTENSION ON
NAVAL BASE KITSAP BANGOR, ENVIRONMENTAL IMPACT
STATEMENT

You may also submit comments online at www.nbkeis.com/lwi.
All comments must be received by **Sunday, March 17, 2013**, to be
considered in the development of the Draft EIS.

For more information about the EIS, please visit the project
website at www.nbkeis.com/lwi.

While the Navy has already briefed you on the proposed projects, we are interested in discussing these projects with you further as details of the projects emerge. I am aware of the significant value of natural and cultural resources of your Tribe within the EIS Study Area, and I look forward to discussing your questions and concerns about the proposed projects. I am available to meet with you at your convenience. Please feel free to contact me directly at (360) 627-4000 or peter.m.dawson@navy.mil, or contact my Environmental Director, Mr. Greg Leicht, at 360-315-5411 or gregory.leicht@navy.mil.

Sincerely,



P. M. DAWSON
Captain, U. S. Navy
Commanding Officer

Enclosure: 1. Site location map for Naval Base Kitsap Bangor



DEPARTMENT OF THE NAVY
NAVAL BASE KITSAP
120 SOUTH DEWEY ST
BREMERTON, WA 98314-5020

5090
Ser PRB4/00115
24 Jan 14

Allyson Brooks, PhD
State Historic Preservation Officer
Department of Archaeology and Historic Preservation
P.O. Box 48343
Olympia, WA 98504-8343

Dear Dr. Brooks:

SUBJECT: REQUEST FOR CONCURRENCE WITH THE AREA OF POTENTIAL EFFECT FOR THE LAND-WATER INTERFACE PROJECT AT NAVAL BASE KITSAP BANGOR

The U.S. Navy proposes to construct the Land-Water Interface Project (Undertaking) between existing waterborne security barriers and the Waterfront Enclave fence (DAHP Log No. 051209-25-USN) at Naval Base (NAVBASE) Kitsap Bangor, Kitsap County, Washington (Enclosure 1). The Navy received concurrence on the Area of Potential Effect (APE) and Determination of No Historic Properties Affected for geotechnical testing associated with this Undertaking in August 2011 (DAHP Log No.:082311-09-USN). In accordance with Section 106 of the National Historic Preservation Act of 1966, as amended (16 U.S.C. 470f), and its implementing regulation, 36 CFR 800, and the consultation of August 2011, the Navy is submitting a definition of APE for the proposed Undertaking.

The purpose of this proposed Undertaking is to secure the perimeter of the Waterfront Restricted Area (WRA) at NAVBASE Kitsap Bangor by extending an existing floating Port Security Barrier (PSB) system to the shoreline at the northern and southern extent of the WRA, thereby securing the entire perimeter of the WRA. Specifically, the Undertaking would modify the existing PSB system to extend across the intertidal zone to attach to concrete abutments at the shoreline at the north and south ends of the existing Waterfront Enclave fence.

The area of potential effect (APE) for this proposed Undertaking comprises two parts: (1) submerged, intertidal, and upland footprint of the proposed undertaking (areas in red, Enclosures 2 and 3) and (2) the view shed (areas in cross-hatch, Enclosures 2 and 3) within which visual changes associated with

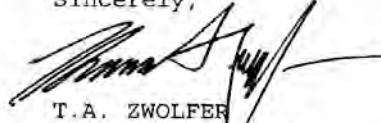
SUBJECT: REQUEST FOR CONCURRENCE WITH THE AREA OF POTENTIAL EFFECT FOR THE LAND-WATER INTERFACE PROJECT AT NAVAL BASE KITSAP BANGOR

the undertaking may affect historic properties such as historic buildings and structures and properties of traditional religious and cultural importance to affected tribes.

The Navy is currently consulting with the five affected tribes with interests along the NAVBASE Kitsap Bangor shoreline. The Navy's definition of the APE is being provided to the Skokomish, Port Gamble S'Klallam, Jamestown S'Klallam, Lower Elwha Klallam and Suquamish Tribes for their review and comment.

The Navy requests your concurrence on our determination of the APE for the proposed Undertaking (construction of the Land-Water Interface project). If you require further information or have any questions, please contact David Grant at (360) 396-0919 or dave.m.grant@navy.mil.

Sincerely,



T.A. ZWOLFER
Captain, U.S. Navy
Commanding Officer

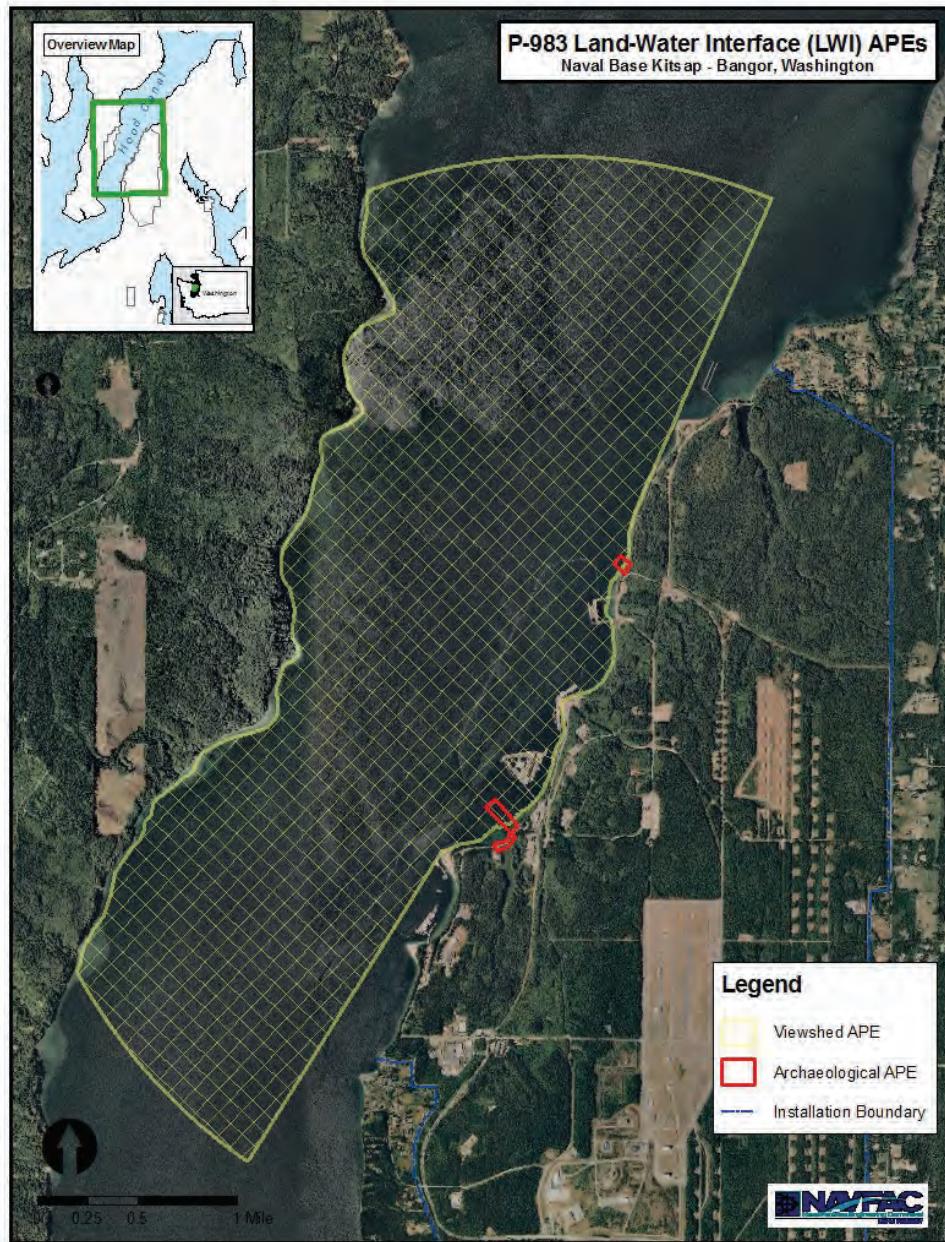
Enclosures: 1. Project Location Map
 2. Proposed APE on Aerial Imagery
 3. Proposed APE on USGS Topographic Map

Enclosure 1. Project Location Map

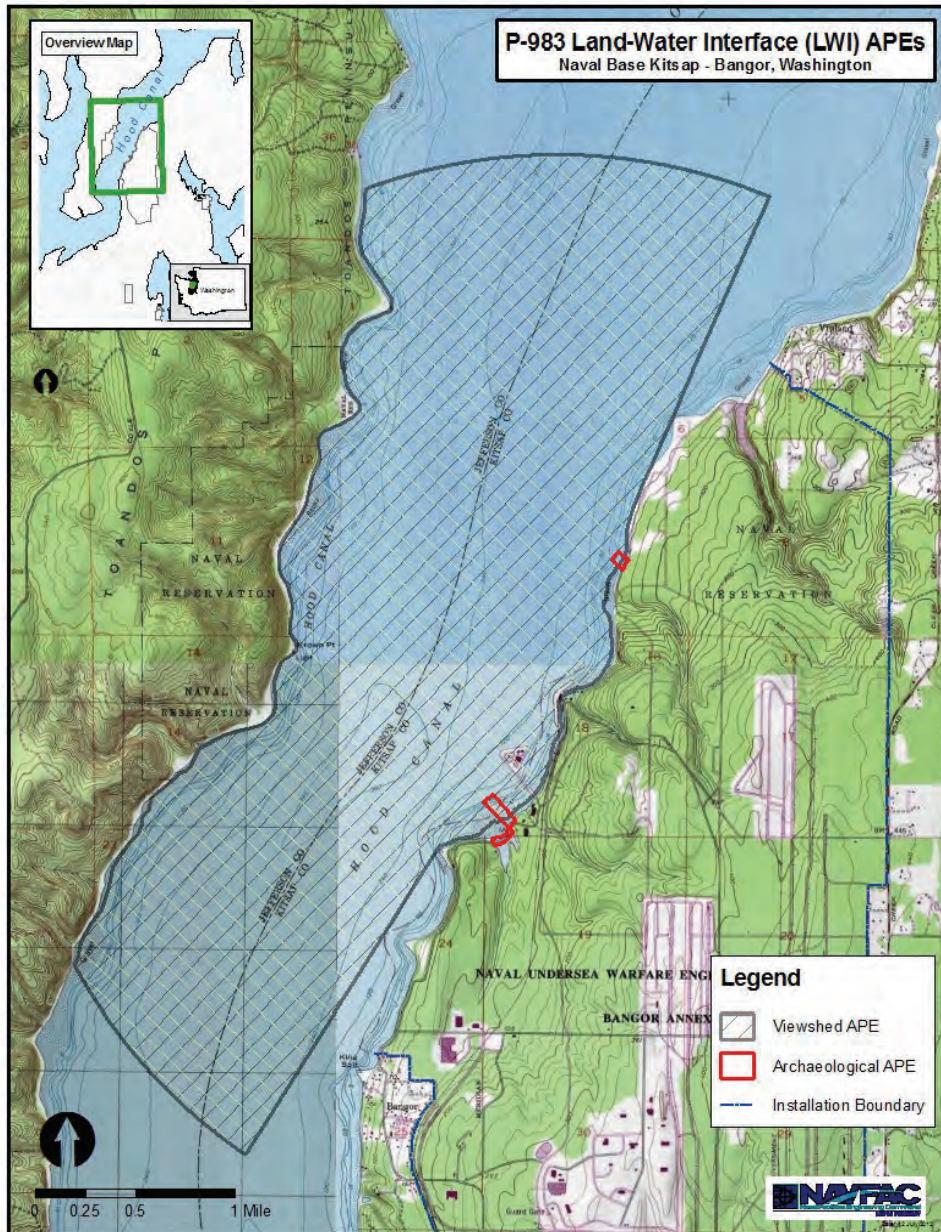


Land-Water Interface Project Location

Enclosure 2. Proposed APE on Aerial Imagery



Enclosure 3. Proposed APE on USGS Topographic Map



This page is intentionally blank.



DEPARTMENT OF THE NAVY
NAVAL BASE KITSAP
120 SOUTH DEWEY ST
BREMERTON, WA 98314-5020

5090
Ser PRB4/00114
24 Jan 14

The Skokomish Tribe
The Honorable Guy Miller
North 80 Tribal Center Road
Skokomish WA 98584

Dear Chairman Miller:

SUBJECT: REQUEST FOR CONCURRENCE WITH THE AREA OF POTENTIAL EFFECT FOR THE LAND-WATER INTERFACE PROJECT AT NAVAL BASE KITSAP BANGOR

The U.S. Navy proposes to construct the Land-Water Interface Project between existing waterborne security barriers and the Waterfront Enclave fence at Naval Base (NAVBASE) Kitsap Bangor, Kitsap County, Washington (Enclosure 1). In accordance with Section 106 of the National Historic Preservation Act of 1966, as amended (16 U.S.C. 470f), and its implementing regulation, 36 CFR 800, the Navy is proposing an Area of Potential Effect for the proposed project for your review and consideration.

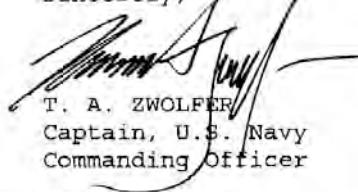
The purpose of this proposed Undertaking is to secure the perimeter of the Waterfront Restricted Area (WRA) at NAVBASE Kitsap Bangor by extending an existing floating Port Security Barrier (PSB) system to the shoreline at the northern and southern extent of the WRA, thereby securing the entire perimeter of the WRA. Specifically, the Undertaking would modify the existing PSB system to extend across the intertidal zone to attach to concrete abutments at the shoreline at the north and south ends of the existing Waterfront Enclave fence.

The area of potential effect (APE) for this proposed Undertaking comprises two parts. First, the submerged, intertidal, and upland footprint of the proposed (areas in red, Enclosures 2 and 3) and, second, the view shed (areas in cross-hatch, Enclosures 2 and 3) within which visual changes associated with the undertaking may affect historic properties such as historic buildings and structures and properties of traditional religious and cultural importance to your tribe.

SUBJECT: REQUEST FOR CONCURRENCE WITH THE AREA OF POTENTIAL EFFECT FOR THE LAND-WATER INTERFACE PROJECT AT NAVAL BASE KITSAP BANGOR

The Navy requests your concurrence on our definition of the APE for the proposed construction of the Land-Water Interface project. If you require further information or have any questions, please contact David Grant at (360) 396-0919 or dave.m.grant@navy.mil.

Sincerely,



T. A. ZWOLFER
Captain, U.S. Navy
Commanding Officer

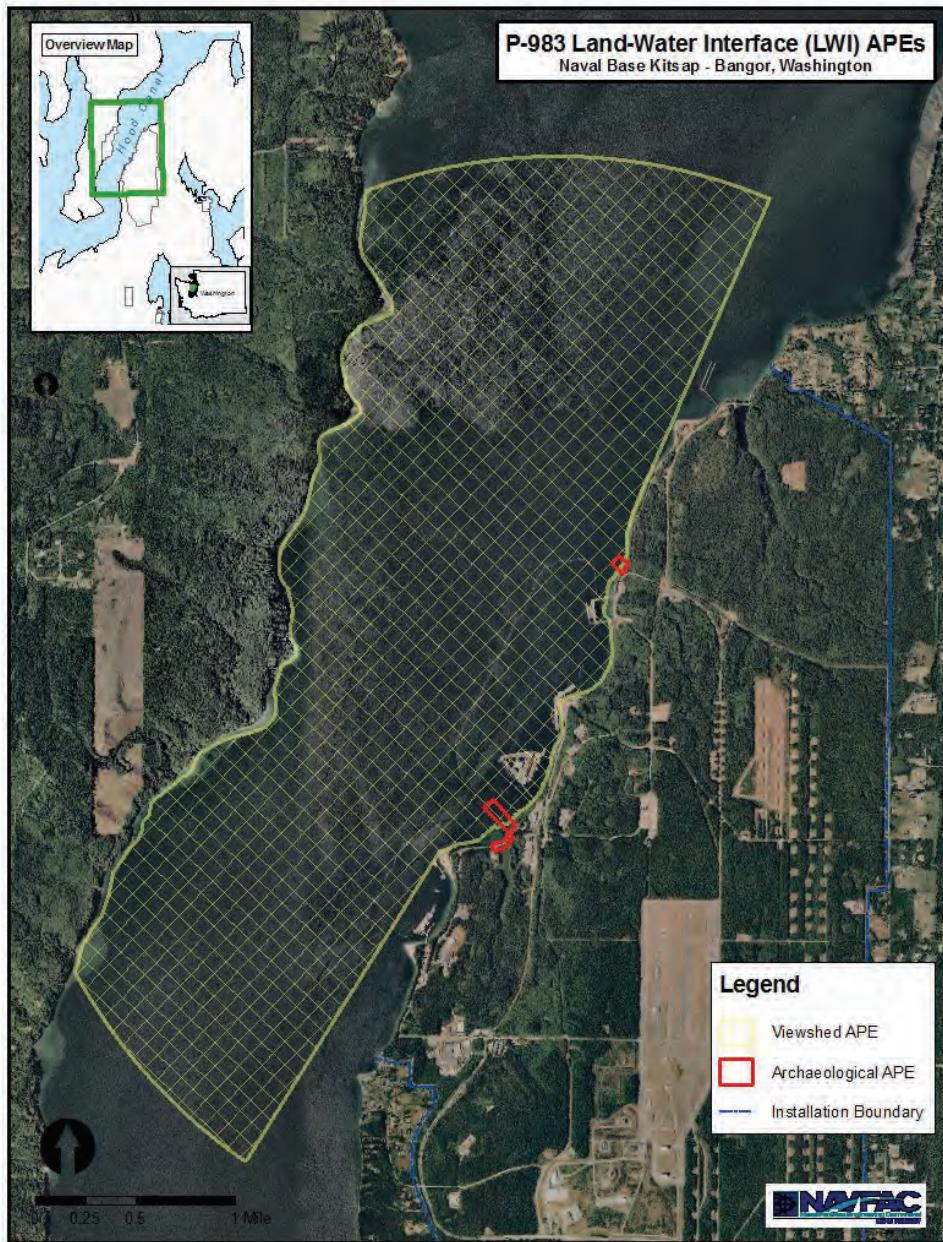
Enclosures: 1. Project Location Map
 2. Proposed APE on Aerial Imagery
 3. Proposed APE on USGS Topographic Map

Enclosure 1. Project Location Map

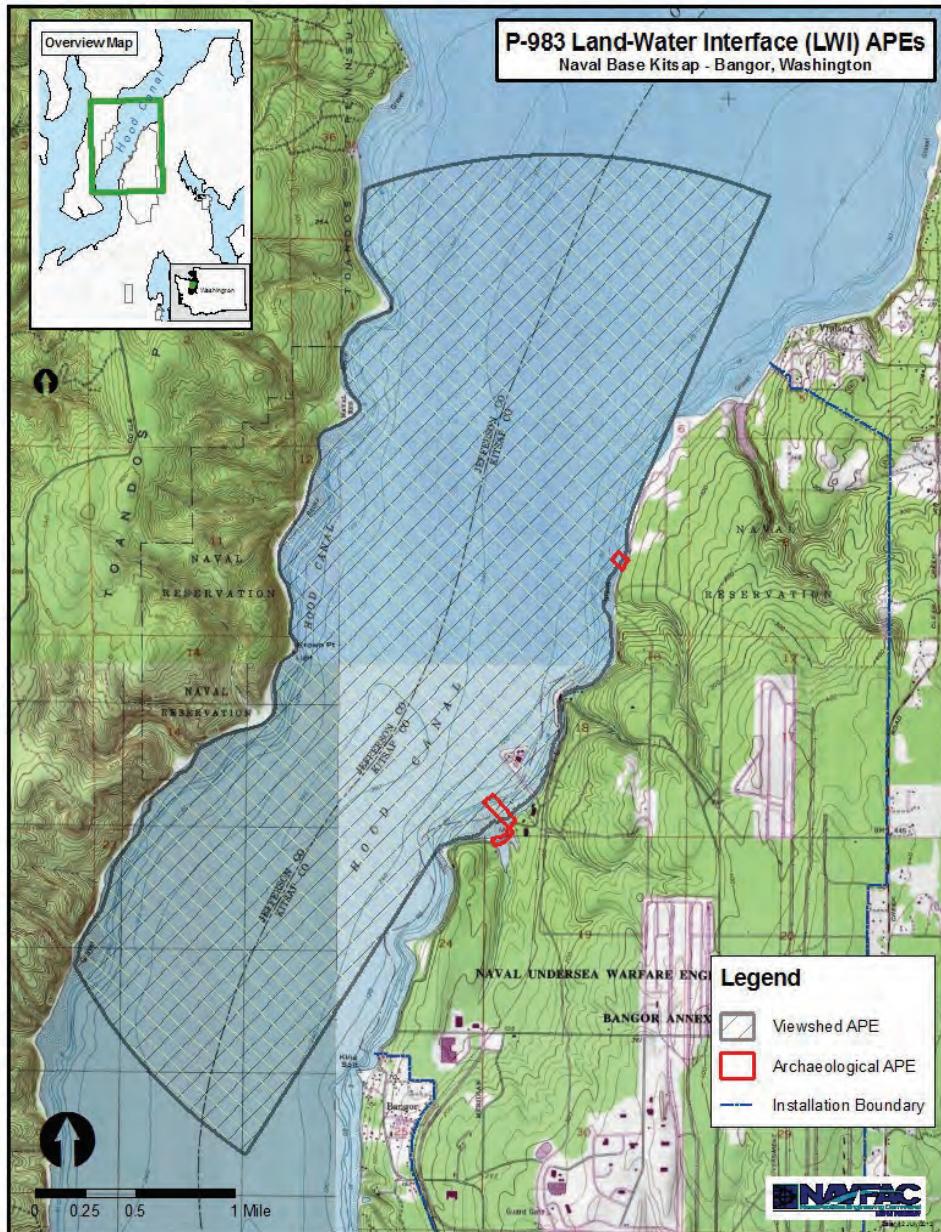


Land-Water Interface Project Location

Enclosure 2. Proposed APE on Aerial Imagery



Enclosure 3. Proposed APE on USGS Topographic Map



This page is intentionally blank.



DEPARTMENT OF THE NAVY
NAVAL BASE KITSAP
120 SOUTH DEWEY ST
BREMERTON, WA 98314-5020

5090
Ser PRB4/00110
24 Jan 14

The Honorable Leonard Forsman
The Suquamish Tribe
PO Box 498
Suquamish, WA 98392

Dear Chairman Forsman;

SUBJECT: REQUEST FOR CONCURRENCE WITH THE AREA OF POTENTIAL EFFECT FOR THE LAND-WATER INTERFACE PROJECT AT NAVAL BASE KITSAP BANGOR

The U.S. Navy proposes to construct the Land-Water Interface Project between existing waterborne security barriers and the Waterfront Enclave fence at Naval Base (NAVBASE) Kitsap Bangor, Kitsap County, Washington (Enclosure 1). In accordance with Section 106 of the National Historic Preservation Act of 1966, as amended (16 U.S.C. 470f), and its implementing regulation, 36 CFR 800, the Navy is proposing an Area of Potential Effect for the proposed project for your review and consideration.

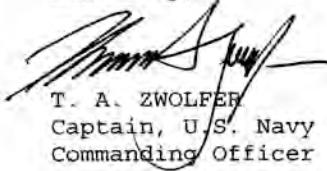
The purpose of this proposed Undertaking is to secure the perimeter of the Waterfront Restricted Area (WRA) at NAVBASE Kitsap Bangor by extending an existing floating Port Security Barrier (PSB) system to the shoreline at the northern and southern extent of the WRA, thereby securing the entire perimeter of the WRA. Specifically, the Undertaking would modify the existing PSB system to extend across the intertidal zone to attach to concrete abutments at the shoreline at the north and south ends of the existing Waterfront Enclave fence.

The area of potential effect (APE) for this proposed Undertaking comprises two parts. First, the submerged, intertidal, and upland footprint of the proposed (areas in red, Enclosures 2 and 3) and, second, the view shed (areas in cross-hatch, Enclosures 2 and 3) within which visual changes associated with the undertaking may affect historic properties such as historic buildings and structures and properties of traditional religious and cultural importance to your tribe.

SUBJECT: REQUEST FOR CONCURRENCE WITH THE AREA OF POTENTIAL EFFECT FOR THE LAND-WATER INTERFACE PROJECT AT NAVAL BASE KITSAP BANGOR

The Navy requests your concurrence on our definition of the APE for the proposed construction of the Land-Water Interface project. If you require further information or have any questions, please contact David Grant at (360) 396-0919 or dave.m.grant@navy.mil.

Sincerely,



T. A. ZWOLFER
Captain, U.S. Navy
Commanding Officer

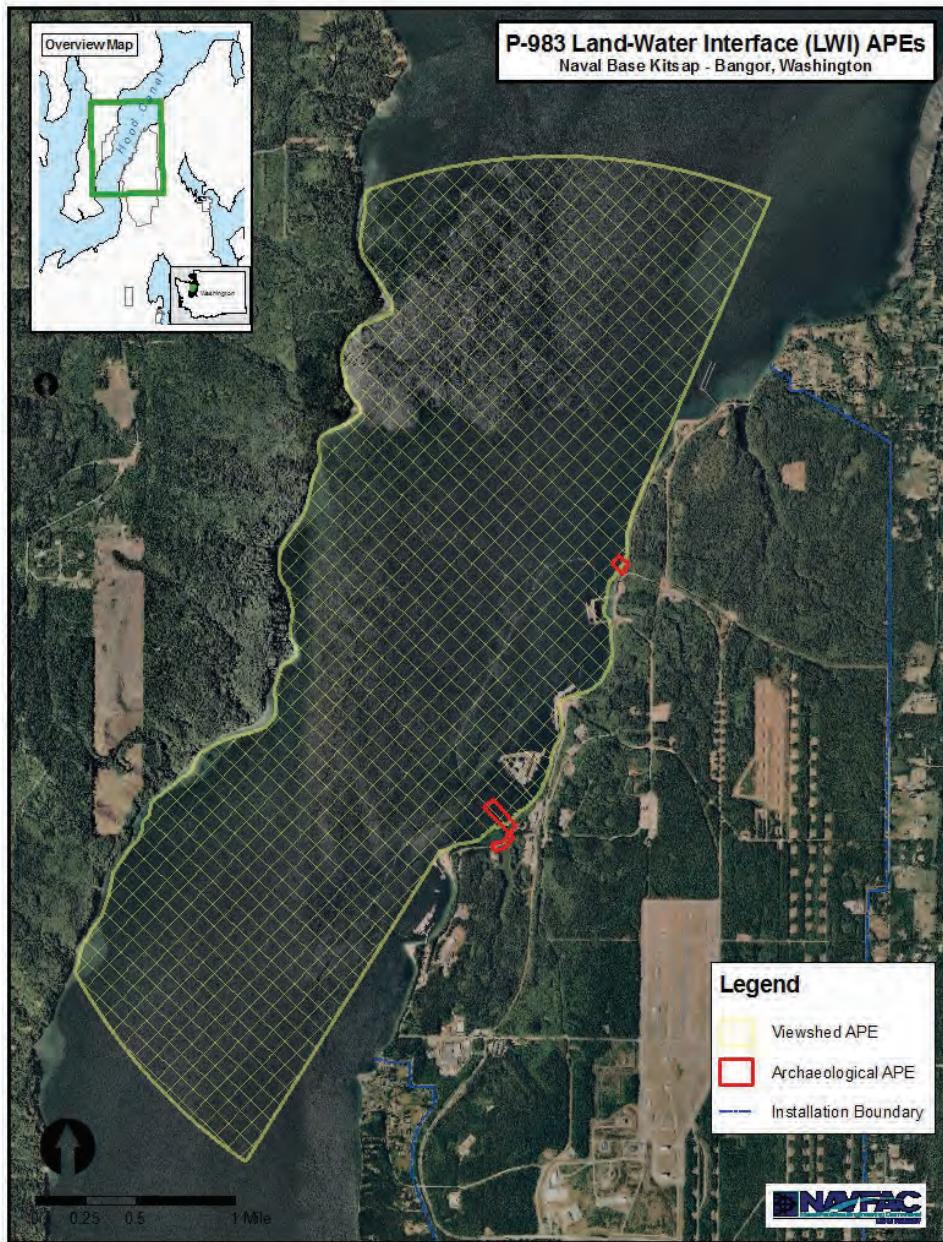
Enclosures: 1. Project Location Map
 2. Proposed APE on Aerial Imagery
 3. Proposed APE on USGS Topographic Map

Enclosure 1. Project Location Map

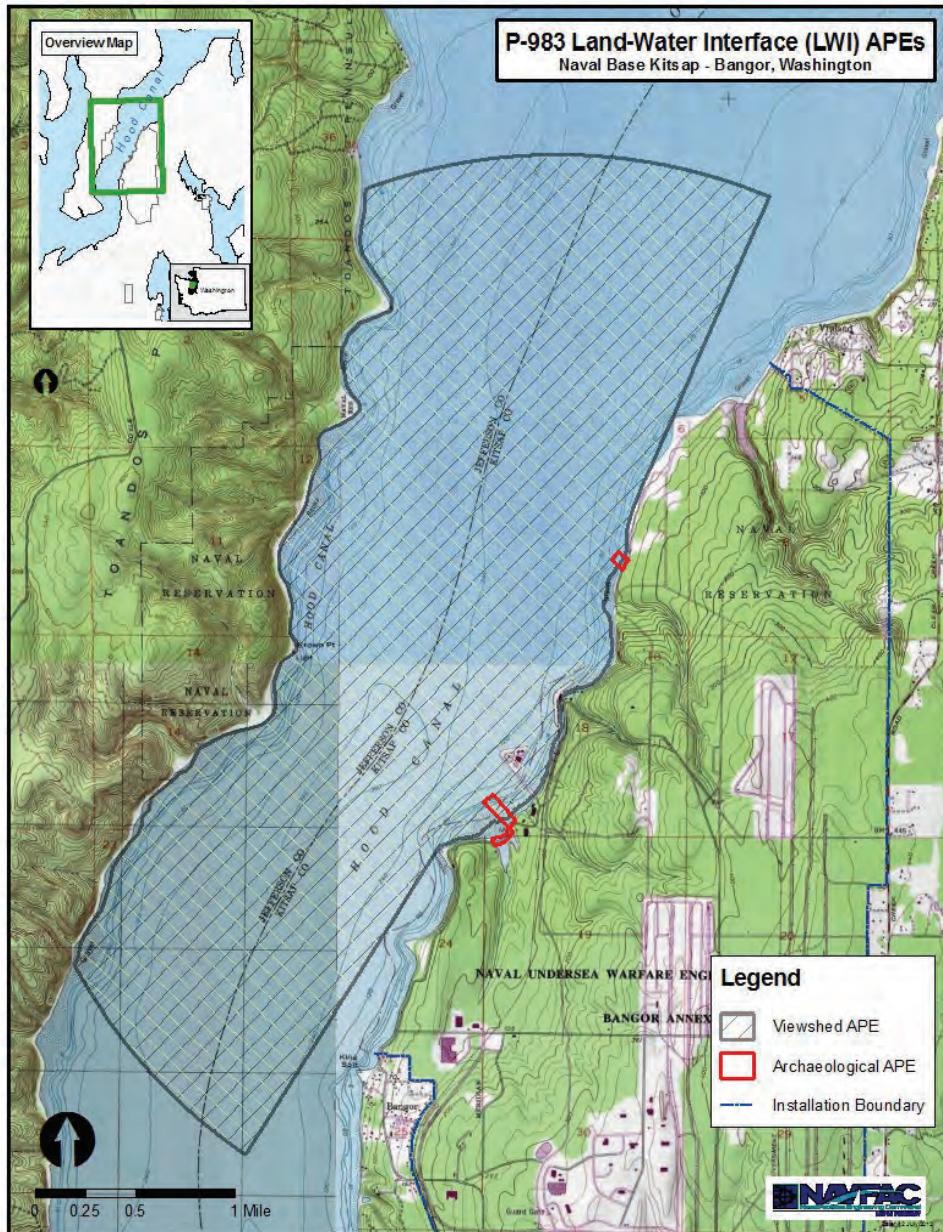


Land-Water Interface Project Location

Enclosure 2. Proposed APE on Aerial Imagery



Enclosure 3. Proposed APE on USGS Topographic Map



This page is intentionally blank.



Allyson Brooks Ph.D., Director
State Historic Preservation Officer

January 13, 2014

Captain T.A. Zwolfer
Naval Base Kitsap
Department of the Navy
120 South Dewey Street
Bremerton, Washington 98314

RE: Land-Water Interface Project
Log No. 012814-11-USN

Dear Commander Zwolfer;

Thank you for contacting our department. We have reviewed the materials you provided for the proposed Land-Water Interface Project at Naval Base Kitsap Bangor, Kitsap County, Washington.

We concur with your determination of the Area of Potential Effect (APE) as described and presented in your figures and text.

We look forward to the results of your professional cultural resources review, your consultations with concerned tribes, and Determination of Effect.

We would appreciate receiving any correspondence or comments from concerned tribes or other parties that you receive as you consult under the requirements of 36CFR800.4(a)(4).

These comments are based on the information available at the time of this review and on the behalf of the State Historic Preservation Officer in conformance with Section 106 of the National Historic Preservation Act, as amended, and its implementing regulations 36CFR800. Should additional information become available, our assessment may be revised. Thank you for the opportunity to comment and a copy of these comments should be included in subsequent environmental documents.

Sincerely,

Robert G. Whitlam, Ph.D.
State Archaeologist
(360) 586-3080
email: rob.whitlam@dahp.wa.gov

State of Washington • **Department of Archaeology & Historic Preservation**
P.O. Box 48343 • Olympia, Washington 98504-8343 • (360) 586-3065
www.dahp.wa.gov



This page is intentionally blank.

Regulatory Consultations

This page is intentionally blank.



DEPARTMENT OF THE NAVY
NAVAL BASE KITSAP
120 SOUTH DEWEY ST
BREMERTON, WA 98314-5020

5090
Ser PRB4 / 02013
17 Nov 14

Mr. Ben Laws
NOAA Fisheries Service
Office of Protected Resources
1315 East West Highway, F/PR1
Silver Spring, MD 20910

Dear Mr. Laws:

SUBJECT: PRELIMINARY DRAFT ENVIRONMENTAL IMPACT STATEMENT FOR THE LAND-WATER INTERFACE AND SERVICE PIER EXTENSION AT NAVAL BASE KITSAP BANGOR, WASHINGTON

The National Oceanic and Atmospheric Administration Fisheries Service (NOAA) is one of the Cooperating Agencies in the preparation of the Navy's Environmental Impact Statement (EIS) for the construction and operation of two separate projects at Naval Base (NAVBASE) Kitsap Bangor, Washington: the Land-Water Interface (LWI) and the Service Pier Extension (SPE). Enclosed is Version 3 draft EIS for NOAA's review and comment. Please provide review comments by 4 Dec 2014. NOAA's review will be valuable in determining compliance with the Endangered Species Act and the Marine Mammal Protection Act as well as improving the overall quality of the document. We appreciate NOAA's continued review and assistance.

The current EIS schedule anticipates public review, with public hearings of the Draft EIS, occurring between 24 and 25 Feb 2015. Meetings with your regional staff will be scheduled during that timeframe if requested.

The point of contact for this EIS is Mr. Thomas Dildine, Naval Facilities Engineering Command Northwest. He can be reached at (360) 396-0018, or at thomas.dildine@navy.mil.

Sincerely,

A handwritten signature in black ink, appearing to read "T. A. ZWOLFER".

T. A. ZWOLFER
Captain, U.S. Navy
Commanding Officer

Enclosures: 1. LWI SPE Preliminary Draft Environmental Impact Statement

This page is intentionally blank.



DEPARTMENT OF THE NAVY
NAVAL BASE KITSAP
120 SOUTH DEWEY ST
BREMERTON, WA 98314-5020

5090
Ser PRB4/02068
24 Nov 14

Mr. Ben Laws
NOAA Fisheries Service
Office of Protected Resources
1315 East West Highway, F/PR1
Silver Spring, MD 20910

Dear Mr. Laws:

SUBJECT: INCIDENTAL HARASSMENT AUTHORIZATION REQUEST FOR THE SERVICE PIER EXTENSION AT NAVAL BASE KITSAP BANGOR, SILVERDALE, WASHINGTON

In accordance with the Marine Mammal Protection Act, as amended and 50 Code of Federal Regulations Part 216.016, the United States Navy requests an Incidental Harassment Authorization for the take of marine mammals associated with the Service Pier Extension project at Naval Base Kitsap Bangor from July 16, 2016 through July 15, 2017.

The proposed action would expose marine mammals in Hood Canal to sound from pile driving. Enclosures (1) and (2) contain information required by the National Marine Fisheries Service for consideration of an incidental take request. The monitoring plan will be developed by the construction contractor and submitted to NMFS prior to In-Water Work commencing.

We appreciate your continued support in helping the Navy to meet its environmental responsibilities. For additional comments or questions the Navy's point of contact is Mr. Thomas Dildine, Naval Facilities Engineering Command Northwest. He can be reached at (360) 396-0018, or by e-mail at thomas.dildine@navy.mil.

Sincerely,

T. A. ZWOLFER
Captain, U.S. Navy
Commanding Officer

Enclosures: 1. Incidental Harassment Authorization Application
2. CD-ROM of IHA application & transmittal letter (2 copies)

Copy to:
Chief of Naval Operations (N45)
Navy Region Northwest (N45)

This page is intentionally blank.

APPENDIX H

PROXY SOURCE SOUND LEVELS AND POTENTIAL BUBBLE CURTAIN ATTENUATION FOR ACOUSTIC MODELING OF NEARSHORE MARINE PILE DRIVING AT NAVY INSTALLATIONS IN PUGET SOUND

**Proxy Source Sound Levels and Potential
Bubble Curtain Attenuation for Acoustic
Modeling of Nearshore Marine Pile Driving
at Navy Installations in Puget Sound**



Final
September 2014

Prepared By:



1101 Tautog Circle Suite 203
Silverdale, Washington 98315-1101

*Proxy Source Sound Levels and Bubble Curtain Attenuation
September 2014*

Table of Contents

1	Background	1
2	Proxy Source Sound Levels for Acoustic Modeling of Nearshore Marine Pile Driving at Navy Installations in Puget Sound.....	3
2.1	Underwater Pile Driving Source Levels	3
2.1.1	Data Sources	3
2.1.2	Other Considerations in Evaluation of Pile Driving Source Values.....	4
2.1.3	Impact Driving Source Values.....	7
2.1.4	Vibratory Pile Driving Source Values	14
2.2	Airborne Pile Driving Source Values	16
3	Evaluation of Potential Bubble Curtain Sound Attenuation.....	19
3.1	Noise Attenuation Assumptions for Acoustic Modeling.....	19
4	References.....	23
	Appendix A: Studies Reviewed for Evaluation of Underwater Pile Driving Sound	A-1
	Appendix B: Data Charts for Measured Data and Cumulative Probability Distribution Functions.....	B-1

*Proxy Source Sound Levels and Bubble Curtain Attenuation
September 2014*

1 Background

The National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service (USFWS) issue incidental take for Endangered Species Act (ESA)-listed species potentially adversely affected by the Navy's activities. This includes sound pressure levels (SPLs) produced from pile driving. Incidental take statements (ITS) are an outcome of Section 7 consultations and addressed in the Biological Opinions. The NMFS also issues authorizations for noninjurious take (Level B) for marine mammals for noise produced by pile driving. Such take provisions are authorized by the Marine Mammal Protection Act.¹

ITS often authorize incidental take by the area encompassed within zones above noise thresholds for ESA-listed fish. ITS for other animals such as marbled murrelets and marine mammals are based upon the number of animals anticipated to occur in the zones above the noise thresholds. For example, the peak SPL for the onset of injury threshold for fish is 206 dB referenced to 1 micropascal (μPa)². If actual project noise exceeds the extent of the modeled authorized area, the project would exceed authorized incidental take allotted in the ITS. Consequently, the project would be required to reinitiate consultation under Section 7 of the ESA and a shut-down of impact pile driving would occur until a new ITS is issued. For marbled murrelets and marine mammals, injurious incidental take is avoided by monitoring areas exceeding the injury thresholds. If an animal enters this area, pile driving is shut down until it leaves. In addition, there can be provisions in an ITS or MMPA authorization allocating incidental take for potential behavioral disturbance. In this case, monitoring is required within the behavioral disturbance zones. Therefore, accurate establishment of the extent of the area exceeding established thresholds is essential to complying with the terms of an ITS or MMPA authorization.

When possible data obtained for a given site are used to predict expected source levels, However, for most project sites, prior measurements of the extent of pile driving noise have not been made. For these sites the extents of the areas where noise exceeds threshold values are modeled with an equation for sound propagation using proxy values for the source pile driving levels. Proxy source values are therefore either from prior measurements obtained on-site by installing the same type and size of piles or, when site specific information is lacking, obtained from the same or most similar type and size pile at locations with a similar sound environment. Other important factors include the type of equipment used to install the pile, substrate type, and water depth, all of which result in variations in pile driving noise levels. Detailed analyses of these factors are beyond the scope of this source document. The following section considers the rationale we used when reviewing proxy impact and vibratory pile driving source values for noise threshold metrics. We first discuss the available data included in the review. Second, we discuss the values for each threshold metric (peak SPL, root-mean-square [RMS], and sound

¹ New NMFS criteria using frequency weighted (filtered) responses are in development, with new standards anticipated. The current revision of this document does not include frequency weighted results; such results will be promulgated in a revised edition.

² All peak and root-mean-square (RMS) sound pressure levels in this document are referenced to 1 μPa . All sound exposure levels (SEL) in this document are referenced to 1 $\mu\text{Pa}^2\text{-second}$. All peak SPLs in this document refer to absolute peak overpressures or under pressures.

*Proxy Source Sound Levels and Bubble Curtain Attenuation
September 2014*

exposure level [SEL]) that will result in a high likelihood of encompassing the extent of actual project noise levels. Last, we review relevant data available for various types and sizes of piles typically used for pile driving and recommend proxy source values for Navy installations in Puget Sound.

Section 2 of this document is a review of attenuation levels reported for various impact pile driving projects.

*Proxy Source Sound Levels and Bubble Curtain Attenuation
September 2014*

2 Proxy Source Sound Levels for Acoustic Modeling of Nearshore Marine Pile Driving at Navy Installations in Puget Sound

2.1 Underwater Pile Driving Source Levels

2.1.1 Data Sources

Differences in underwater source levels for a given pile size and type will vary because of differences in geologic conditions, water depths where piles are installed, and pile driver type. In other words, the same size pile and type may generate different noise characteristics when installed in dissimilar environments. To obtain source values and model distances to the USFWS and NMFS thresholds for nearshore marine environments at Navy installations in Puget Sound, we reviewed available values from multiple nearshore marine projects obtained from the California Department of Transportation (CALTRANS), Washington State Department of Transportation (WSDOT), and Navy pile driving acoustic reports. Projects were located in California, Oregon, and Washington. Non-marine projects were excluded because of differences in substrate and/or acoustic conditions, and are not relevant herein due to the dissimilar nature from typical work performed at Navy marine facilities in Puget Sound. For example, a project located in Lake Washington and a freshwater bay (SR 520 Test Pile Project) was excluded due to very different substrate conditions present at those sites. Projects located in rivers were excluded because substrate characteristics, such as presence of bedrock, were not typical of Puget Sound. River projects also had different bathymetric profiles as well as increased current velocities. Of the projects reviewed, only measurements from unattenuated piles (e.g. a noise attenuation device was not operating³) were evaluated. Attachments 1 through 5 in Appendix A list the projects considered in this review.

All projects considered in the review had similar nearshore project depths from less than 5 m to approximately 15 m with the exception of Test Pile Program at Naval Base (NAVBASE) Kitsap Bangor where depths ranged from approximately 13 to 27 m. Impact pile driver type is listed in the attachments. Impact pile drivers can be drop, pneumatic, hydraulic, or diesel powered. With some exceptions at the Friday Harbor Ferry Terminal, all impact driven piles were installed with diesel powered drivers. Vibratory drivers vary only by size (energy) and type (variable moment/non-variable moment), but because of the limited data set, no attempt was made to distinguish between driver energies when reviewing noise levels produced from different impact or vibratory drivers.

Proxy values in similar marine sound environments can be challenging to obtain for pile driving because of variations in geologic conditions between projects and variability within project sites. Substrate types were not reported for most projects included in the review. Substrate types typical of Puget Sounds are sand/silt to sand/silt/cobbles overlying glacial till or hard clay layers. Therefore, projects located in the marine waters of Puget Sound, including the San Juan Islands, were considered more heavily because they would be more likely to share the

³ Pile caps are routinely placed on top of piles prior to driving to cushion equipment. While they are recognized as providing some sound attenuation, they are not considered in this analysis because they are part of baseline sound measurement presented in many reports.

*Proxy Source Sound Levels and Bubble Curtain Attenuation
September 2014*

same substrate characteristics than projects located in the San Francisco Bay area, the mouth of the Columbia River, or coastal bays. However, it should be noted that within Puget Sound a considerable variability in substrate conditions can exist between projects and within projects due to harder glacial layers and unforeseen encounters with glacial erratics (e.g. erratic rocks). Depending on the substrate type, piles may easily be advanced or, because of glacial till or submarine boulders, piles may require much more energy to drive. Piles driven to different tip elevations could also experience different driving conditions. For example, fender piles generally are not driven to the same depth as structural piles and may not encounter the same resistance during driving. Therefore, considerable variation in values is expected when looking from project to project or pile to pile within a project. To ensure proxy values are protective of species, conservative values were chosen to encompass regional and pile to pile variation. The following section considers the rationale we used when reviewing values for various sound metrics.

2.1.2 Other Considerations in Evaluation of Pile Driving Source Values

Proxy values need to be conservative. This ensures the area modeled above the injury thresholds is correctly assessed and remains within an ITS for fish. This approach will also preclude incidental take considered injurious based on the established injury criteria of marbled murrelets and marine mammals. In addition, proxy values are used to model the areas above the marbled murrelet and marine mammal behavioral thresholds or guidance values. Sound levels from pile driving are reported on either a per pile basis within a project, or per project summary basis. Summary data reported in acoustic reports varies, but can include one or more of the following:

- Per pile averages
- Ranges
- Minimum and maximum values
- Per project average
- Typical values
- Average range
- Minimum, maximum, average minimum
- Average maximum value
- Standard deviation.

Thus, interpretation of the reported levels may depend on the analytical methodology selected, which in turn can affect the proxy source level selected for modeling analysis. For example, one approach to choosing a source value is to pick the mean value from a number of projects reviewed. The results from the model utilizing this mean value will adequately characterize the estimated average extent of noise from pile driving. However, depending on the pile to pile variability it would only characterize the area for individual piles if the pile to pile variability in the source data were low. If the data were highly variable, the extent of the area above the threshold would be smaller or larger than described by the model on a per pile basis. Therefore, on-site monitoring of pile driving noise could exceed the modeled values on a

*Proxy Source Sound Levels and Bubble Curtain Attenuation
September 2014*

significant portion of the piles. Another, but more conservative approach is to select the proxy source value from the highest value of all values reported. This method would ensure that most, if not all, measured values on a pile by pile basis would be below the selected value, but could significantly overestimate the area or extent of biological impact.

In the section below we outline the rationale we used for selecting proxy values from the available data for each threshold metric. Values were chosen to ensure that a reasonable worst case scenario is modeled to estimate the extent of noise from pile driving.

2.1.2.1 Root Mean Square

The root-mean-square (RMS) value is the metric used to define the behavioral zones for fish, marbled murrelets, and marine mammals. For piles that are impact driven, RMS values are generally reported for individual piles over the duration of the driving of a given pile; often the number of strikes is also reported on a per-pile basis. Thus, in order to best characterize a broad-base proxy SPL, average RMS pressures were computed from the reported SPL (dB) values, and then weighted by the number of pile strikes for a given pile. This weighting methodology estimates proxy values across multiple projects with differing numbers of piles or strike counts, and the effect of using weighting values ensures that a single project or pile does not overtly bias the result high or low. This proxy value represents the most likely value expected for individual pile strikes for a typical project.

For piles that are vibratory driven, RMS values are typically computed over 10-second or 30-second averaging periods, and represent the most probable typical value over a long event. Thus, recommended proxy RMS values for vibratory and impact pile driving are computed using different techniques. For vibratory piles, reported values were selected on a pile-by-pile basis for a given pile type and size. An average value was computed by converting selected SPL values (dB) into pressure values, summing them together in linear space, dividing by the total number, n, of selected piles, and converting the result back to SPL (dB). In following this approach, the proxy value represents the arithmetic average value for each pile type and size from applicable projects. Thus, for vibratory driven piles averaged RMS values were used from all applicable projects as a representative average level of long-term pile driving events.

The following equations and calculations are used within this report and appendices to compute average values.

$$\text{Sound Pressure Level (SPL, dB)} = 10 \cdot \log_{10}(\text{Pressure, } \mu\text{Pa})$$

$$\text{Pressure (}\mu\text{Pa)\,}, P = 10^{\left(\frac{\text{SPL,dB}}{10}\right)}$$

Weighted pressures are simply the linear product of the number of events, n, (such as pile strikes), multiplied by the average pressure for the pile, P:

$$\text{Weighted Pressure} = n \cdot P$$

*Proxy Source Sound Levels and Bubble Curtain Attenuation
September 2014*

Weighted SPL averages are computed by first converting all SPL values to linear pressure, weighting pressure (P) values by the number of events (for example, by number of strikes, n), normalizing by dividing by the number of events, and then converting back to SPL. Using k as an index counter for all piles, 1 = pile #1, 2 = pile #2, etc:

$$\text{Weighted SPL} = 10 \log_{10} \left[\frac{1}{n_{total}} \sum_{k=1}^{n_{total}} (n_k P_k) \right]$$

where

$$n_{total} = n_1 + n_2 + n_3 \dots$$

Charts depicting the behavior of the measured data used to prepare proxy values within this document are presented in Appendix B. Two types of charts are provided. First, for all data types, a sorted chart showing amplitude for all piles included, recommended proxy value, and when available, minimum and maximum levels observed. Next, the cumulative probability distribution function charts are provided for all pile sizes, with the recommended proxy value annotated on each chart.

2.1.2.2 Peak Sound Pressure Level

The peak sound pressure level (SPL) metric is used to evaluate the potential for injurious effects to fish. The barotrauma injury to fish due to peak over or under pressurization could result in instantaneous injury with a single strike. Average peak impact SPL values were selected from applicable projects, from which a weighted probability distribution function (PDF) was computed based on the number of pile strikes for each pile. To ensure a conservative proxy value, a value representing the ninetieth percentile of the PDF was selected, meaning that for a typical impact pile driving project, 90% of all pile strikes would typically occur below this proxy value. Use of this value ensures potentially injurious effects to fish would have a high likelihood of being within the area exempted for incidental take.

2.1.2.3 Sound Exposure Level

The sound exposure level (SEL) metric for impact driving is used to calculate the area of cumulative exposure potentially resulting in injury to fish or marbled murrelets over a daylong pile driving event (the accumulation of energy received from all pile strikes). To compute the cumulative SEL all single strike SEL energy in a workday is summed to calculate the overall SEL. However, modeling for the SEL “dosage” generally involves estimation of a typical single pile value logarithmically added to sum the expected energy over the day. While some strikes may be lower and some higher than the mean SEL value, use of the mean value would result in the best overall estimate of expected cumulative energy over the work day. In practice, the SEL value will vary on any given workday due to variability in the levels measured for each individual strike. The acoustic reports reviewed typically provided the mean single strike SEL per pile. Therefore, the most representative estimate of the single strike SEL for a proxy value is to use a mean SEL value from data from all piles in applicable projects. Furthermore, to avoid biasing the data high or low from a single pile or project, a weighted average was computed using the number of pile strikes, n , in the same manner as was followed for computation of

*Proxy Source Sound Levels and Bubble Curtain Attenuation
September 2014*

impact RMS values. This approach ensures that a single project or pile does not bias the result high or low. This proxy value represents the most likely value expected for individual pile strikes for a typical project.

2.1.3 Impact Driving Source Values

Table 2-1 summarizes projects from Attachment 1 in Appendix A that were considered in the final analysis and highlights proxy values. These highlighted proxy source values are reasonably conservative for modeling future Navy pile driving projects in Puget Sound. Detailed discussions of the projects considered and the values obtained for each pile type and size are provided below.

**Table 2-1. Summary of Unattenuated Impact Pile Driving Levels Considered.
Recommended Proxy Source SPLs at 10 m Bolded.**

Pile Size	Number of Projects Considered ¹	Range of Average RMS (n-weighted pile average) dB re 1µPa	Range of Average Peak (90% PDF value) dB re 1µPa	Range of Average SEL (n-weighted pile average) dB re 1µPa
Steel				
24-inch	2	181-198 (193)	196-213 (210)	176-185 (181)
30-inch	3	192-196 (195)	203-217 (216)	182-187 (186)
36-inch (all projects)	3	185-196 (192)	202-211 (211)	173-186 (184)
36-inch (Bangor only)	1	185-196 (194)	Not reported ³	173-183 (181)
All 24/30/36-inch	7	181-198 (193)	196-217 (211)	173-193 (184)
Concrete				
<18-inch	3	158-173 (170) ²	172-188 (184) ²	147-163 (159) ²
24-inch	7	167-179 (174) ²	180-191 (188) ²	158-167 (164) ²

¹See Appendix A, Attachment 1 and 2 for projects reviewed.

²Number of pile strikes, n, was not available for any concrete projects; all piles were equally weighted.

³Although absolute peak values were collected for TPP testing, average peak values were not reported; unattenuated data from EHW-2 was not collected.

2.1.3.1 24-Inch Steel Pile Impact Driving Source Values

Attachment 1 in Appendix A lists six marine nearshore projects reviewed for possible inclusion in the analysis. Data for one 24-inch pile installed with an impact hammer in the Test Pile Project at NBK Bangor are listed in Attachment 1. However, only 7 pile strikes were reported and measurements from this pile are lower than all of the other five projects reviewed. Therefore, these data were not considered in the selection of the most conservative value. Of the remaining five projects reviewed, the Bainbridge Island Ferry Terminal Preservation Project and the Friday Harbor Restoration Ferry Terminal project were considered as the most representative of typical glacial till and erratics encountered in Puget Sound and were carried forward in the analysis. We based this on the assumption that substrate conditions are more similar than those found in San Francisco Bay or the mouth of the Columbia River.

*Proxy Source Sound Levels and Bubble Curtain Attenuation
September 2014*

For the two ferry terminal sites, five piles were driven at Bainbridge Island in substrate that consisted of a mix of sand and fist-sized rocks with occasional rocks one-foot in diameter. At Friday Harbor six piles were driven into a silty sand substrate approximately 9 meters thick and underlain by a hard clay lens. Three of the piles at this site encountered a large rock ledge approximately 10.7 meters below the mudline. One of the six piles in the project had the high end of the data clipped⁴ and therefore invalid, so this pile was excluded from the analysis. This project used different hammer types, but because the report noted little variation in the data, all five remaining piles were included in our review. Data from the two ferry projects only included values without a bubble curtain attenuator operating, i.e. no attenuation.

Source levels for each metric reviewed are discussed below. Table 2-1 summarizes unattenuated impact pile driving source data from Attachment 1 for the two ferry terminal projects.

RMS SPL

Weighted average proxy RMS source values for the two Puget Sound ferry terminal projects were 189 dB (range 181 dB to 193 dB) and 195 dB (range 193 dB to 198 dB) (Attachment 1), representing 1007 pile strikes. Therefore, actual RMS values would be expected to fall between 181 dB and 198 dB. The weighted average RMS value of 193 dB was chosen as a conservative value that likely encompasses the average extent of the area exceeding the injury thresholds for marine mammals and the behavioral thresholds for marine mammals, fish and marbled murrelets.

Peak SPL

Average peak SPLs reported for individual piles at the Bainbridge Island and Friday Harbor projects were 202 dB to 209 dB and 196 dB to 213 dB, with an average weighted value of 207 dB. Of the applicable projects, the 90% probability from the weighted cumulative distribution density function value of 210 dB was chosen as a conservative proxy value that likely encompasses the modeled extent of the area over the onset of injury threshold for fish. Table 2-1 summarizes the values from the two projects considered likely to be most representative.

SEL

Mean weighted SEL values for the two Puget Sound projects reviewed are each 181 dB for all piles. The mean SEL per any one pile for both projects ranged from 176 and 185 dB. These values are higher than the values reported for the other three projects reviewed (project SEL means that ranged from 168 to 177 dB). Therefore, the Washington projects were considered the most conservative and a mean weighted SEL of 181 dB was chosen as a reasonable proxy value of the overall SEL for 24-inch piles.

⁴ Clipping occurs when a signal exceeds the linear limits of an electronics system in essence the extreme levels of the signal are truncated or “clipped” off. For pile driving measurements, clipped data can produce results that are lower than the actual signal of interest, thus producing invalid results.

*Proxy Source Sound Levels and Bubble Curtain Attenuation
September 2014*

2.1.3.2 30-inch Steel Pile Impact Driving Source Values

Data for 30-inch steel pipe piles were available from three marine pile driving projects in Puget Sound, Washington and one project from San Francisco Bay, California. No projects from Bangor were available for analysis, and data from the California project provided only typical data, and did not provide per-pile SPL or number of strikes for each pile (see Attachment 1 in Appendix A). All available data in Attachment 1 were reviewed. However, as with the 24-inch pile source values, values from the Puget Sound projects were considered the most representative of source values because of similar substrate characteristics and are the only values considered in the Table 2-1 summary. Note that data from the Vashon Island project were acquired from 7m to 16m from the pile, and were normalized using a $15 \cdot \log_{10}(\text{range}/10\text{m})$ relationship.

RMS SPL

Average RMS source values for three Puget Sound projects ranged from 192 dB to 196 dB. The minimum average value reported for any one pile is 192 dB (Eagle Harbor Ferry Terminal) and a maximum average reported of 196 dB (Vashon Island Ferry Terminal, two piles). The RMS values from three Puget Sound projects were moderately higher than values measured from the California project considered, which reported a typical RMS value 190 dB. A conservative proxy RMS value is the weighted average value of 195 dB from the three projects in Puget Sound representing 263 pile strikes. This value would be a reasonable worst case ensuring that noise levels modeled would have a high likelihood of not exceeding this value.

Peak SPL

Average peak SPLs reported from the Puget Sound projects with available data ranged from 203 dB to 217 dB (n=3 projects) on a per-pile basis, with a computed weighted average of 214 dB. Levels from three piles at Eagle Harbor Ferry Terminal range from 7 to 11 dB quieter than those measured at two other Puget Sound sites, indicating a significant variability between sites. The typical peak SPL reported for the single California project was 205 dB, which was noted to be on the lower end of the range of data reported from Puget Sound, although the number of pile strikes was not reported, thus this data were not included in the weighted average for 30" peak values. The 90% weighted cumulative probability value of 216 dB was chosen as a reasonable and conservative proxy value.

SEL

Average per-pile SEL values were reported for the two Puget Sound Projects representing 214 pile strikes; the Eagle Harbor project did not report single strike SEL levels, and a California project did not report any SEL levels. SEL values from the two applicable projects ranged from 182 dB to 187 dB with an overall weighted average of 186 dB. Thus, a reasonable conservative SEL source value for future projects in Puget Sound is 186 dB derived from the weighted value of reported Puget Sound levels.

*Proxy Source Sound Levels and Bubble Curtain Attenuation
September 2014***2.1.3.3 36-inch Steel Pile Impact Driving Source Values**

Data for 36-inch steel pipe piles were available from three marine pile driving projects in Puget Sound, Washington and one project from Humboldt Bay along the California coast (Attachment 1 in Appendix A). All projects installed piles with a diesel hammer. The Humboldt Bay project did not report number of pile-strikes, and furthermore, this pile was only measured by re-striking a pile that had already been driven. Therefore, this project was excluded from the 36-inch average value computations. Data from two piles measured during the NBK Bangor Test Pile Program were at 11m and 20m from the pile, and were normalized using a $15 \cdot \log_{10}(\text{range}/10\text{m})$ relationship.

RMS SPL

Average RMS source values for the three Puget Sound projects ranged from 185 dB to 196 dB, representing 662 pile strikes, the full range of which were observed during the Test Pile Program at NBK Bangor project. The weighted average value for these projects was 192 dB, and represents a reasonable proxy RMS value for impact driven 36-inch piles. The average RMS value of 193 dB reported for the 36-inch pile from the Humboldt Bay Bridge project in California fell within the range of values for the three Washington 36-inch pile projects reviewed, although as previously discussed, this value was not included in the averaging calculations. Considering just the Test Pile Program at Bangor, 121 pile strikes produced a set of measurements ranging from 185 to 196 dB, with a weighted average value of 194 dB.

Peak SPL

Average peak SPLs reported from two Puget Sound projects ranged from 202 dB to 211 dB on a per-pile basis, representing 541 pile strikes. Average peak values were not reported for the NBK Bangor project. A proxy peak value of 211 dB was chosen representing the 90% cumulative probability SPL.

SEL

Average SEL values were reported for three Puget Sound projects, with 662 pile strikes measured. SEL values ranged from 173 dB to 186 dB with an overall weighted average of 184 dB, the recommended proxy value for piles driven in Puget Sound. Only one value was reported for the Humboldt Bay project, 183 dB, which was within the range of values reported in Puget Sound. A reasonable conservative SEL source value for future projects in Puget Sound is 184 dB derived from the weighted average of three Puget Sound projects. Analyzing data from just the NBK Bangor project resulted in a weighted average value of 181 dB, with a data range of 173 to 183 dB.

2.1.3.4 Combined Steel Pipe Impact Driving Source Values

Review of RMS, average peak, and SEL values for steel pipe piles of 24, 30, and 36-inches shows that often only slight differences are noted across the three sizes (see Table 2-1). In some cases, weighted average values for smaller piles are higher than for larger piles, even if by only

*Proxy Source Sound Levels and Bubble Curtain Attenuation
September 2014*

one or two decibels. For this reason a combined analysis was done for each of the metrics to investigate the potential value of preparing overall average values over multiple sizes of steel pipe piles. Each of the metrics is discussed in the following paragraphs.

RMS SPL

Average RMS values over 24-, 30-, and 36-inch piles ranged from 181 dB to 198 dB, although weighted averages were very close, 193, 195, and 192 dB, respectively, with an overall weighted average value of 193 dB. 30-inch piles (three projects located in Puget Sound, not including any NBK Bangor projects) produced average RMS levels of 195 dB, higher than both 24-inch and 36-inch average values. Even though few piles and a lower number of pile strikes were measured with 30-inch piles, the scatter in the points measured only ranged from 192 to 196 dB, without a large deviation. 24-inch and 36-inch piles have larger data sets, but nonetheless, the recommended proxy value for each of these sizes is only a few decibels different. Figure B-4 in Appendix B graphically shows how the scatter for each pile size compares with other pile sizes. While it is reasonable to assert that RMS impact values for steel pipe piles can be represented by a single, composite value of 193 dB, additional data is recommended to be collected to increase the size of the analysis sample set.

Peak SPL

Peak SPL values varied over a broader range than RMS values, although 24- and 36-inch 90% cumulative probability results were within 1 dB, representing 1,669 pile strikes. 30-inch results were measurably higher than either 24- or 36-inch data, represented by fewer piles, and fewer strikes (263 strikes). Furthermore, 30-inch pile data is somewhat bi-modal in behavior, with three values near 203 to 204 dB, and four in the 211 to 217 dB range, and nothing in between. Figure B-11 in Appendix B graphically shows the distribution of levels by pile size. Three piles represented in the 211 to 217 dB range were measured from distances other than the standard 10 meter de facto measurement range, which were corrected using the traditional practical spreading model. Although not necessarily incorrect, this serves to increase the uncertainty of those measurements. Since none of the 30-inch (nor 24-inch measurements) represent data acquired directly from NBK projects, it makes sense to prepare a broader analysis to consider different pile sizes for the purpose of increasing confidence in the estimated peak values. The 90% cumulative distribution value for all 24-, 30-, and 36-inch applicable projects is 211 dB, represented by 1,932 pile strikes, and is the recommended proxy value for NBK Bangor projects, especially those using 24-inch and 30-inch steel pipe piles, until such time that Bangor-specific data can be acquired using these pile sizes.

SEL

Weighted average SEL values for 24-, 30-, and 36-inch piles also resulted in somewhat anomalous data with 30-inch steel pipe piles, with both 24-inch and 36-inch data producing lower values. As described above, the 30-inch data set includes range corrected values, and furthermore, only represented 4 piles, since single strike SEL values were not reported for one of the Puget Sound projects (Eagle Harbor Ferry Terminal). Figure B-16 in Appendix B shows the data grouping by pile size. This gives rise to increased uncertainty in the 30-inch average values.

*Proxy Source Sound Levels and Bubble Curtain Attenuation
September 2014*

There is some evidence that SEL values for 36-inch piles at NBK Bangor (182 dB, weighted average) is lower than a proxy value including Puget Sound projects (184 dB). This conclusion is drawn from a modest sample size (4 piles, 121 strikes) of NBK Bangor measurements. Similar analyses could not be done with 24- and 30-inch piles, since these data did not exist for NBK Bangor projects.

Taken in summary, there is motivation to compute a single proxy value for all 24-, 30-, and 36-inch steel pipe piles, but this approach is not recommended at this time due to the uncertainty in the data scatter, and different results among RMS, SEL, and peak metrics. Additional data should be collected before using combined analyses.

2.1.3.5 18-Inch Concrete Pile Impact Driving Source Values

Attachment 2 in Appendix A lists three marine nearshore projects that monitored sound levels during installation of 18-inch or similar (16-inch) concrete piles, none of which were conducted in Puget Sound. Two projects were conducted at the Berkeley Marina in San Francisco Bay, California, one in 2007 and one in 2009 using 18-inch concrete piles. Acoustic measurements were only collected for four piles total for both projects. Water depth was fairly shallow ranging from 3 to 4 meters. Source levels for each metric reviewed are discussed below. Another project located near Concord, CA at the Naval Weapons Station (NWS) drove five 16-inch concrete piles, with water depth of 10 meters. Source values for this project were similar to those for the Berkeley Marina projects, and thus data from the Concord NWS were included in the analysis. Table 2-1 summarizes unattenuated impact pile driving source data from Attachment 2 and highlights recommended proxy source values. Since the number of pile strikes for all concrete projects were not reported, pile averages were computed.

RMS SPLs

Average RMS values for three projects using 16 or 18-inch concrete piles ranged from 158-173 dB (Table 2-1), with an average RMS value of 170 dB over 9 piles, selected as a conservative value likely to encompass the maximum extent of the area exceeding the behavioral thresholds and guidance for marine mammals, fish and marbled murrelets. No concrete pile levels exceed the RMS injury thresholds established for marine mammals (180 dB RMS for cetaceans and 190 dB RMS for pinnipeds).

Peak SPLs

Average peak SPLs reported for all piles at the Berkeley Marina projects ranged from 172 dB to 188 dB. Because only three projects with relatively small samples sizes were available for review, a per-pile average value of 184 dB was chosen as the recommended SPL proxy value for all piles. This value is below the threshold for the onset of injury in fish (206 dB). Table 2-1 summarizes the values from these projects.

*Proxy Source Sound Levels and Bubble Curtain Attenuation
September 2014*

SEL

Two average SEL values of 155 and 159 dB were reported for the two Berkeley marina projects, both with very small sample sets ranging from 147 dB to 163 dB. SEL data were not acquired for the Concord NWS project. The per-pile average value of 159 dB SEL was selected as the most conservative proxy value available for 18-inch concrete piles until additional data are obtained.

2.1.3.6 24-Inch Concrete Pile Impact Driving Source Values

Only one value from a single 24-inch concrete pile was available for the Mukilteo Ferry Terminal in Puget Sound. Therefore, we reviewed seven additional marine projects: six in San Francisco Bay, California, and one in Humboldt Bay, California (Attachment 2 in Appendix A). Note that some of the San Francisco Bay projects included data from the same site in two different time periods. Two projects (Humboldt State Floating Dock and Pier 40 Marina) included piles that were driven using a jetting technique, often in combination with a reduced level of fuel to minimize driving energy. Piles driven under these circumstances were not included in the calculation of piles averages. Table 2-1 summarizes unattenuated impact pile driving source data from Attachment 2 and highlights recommended proxy source values.

RMS SPLs

The one pile in Puget Sound reported a maximum RMS value of 170 dB, with average values reported for the California projects ranging from 167 dB RMS to 179 dB RMS. The recommended proxy source value was chosen from the highest average pile value over all projects, 174 dB RMS (Table 2-1). No concrete pile noise levels exceed the RMS injury threshold established for pinnipeds (190 dB RMS), nor the RMS injury threshold for cetaceans (180 dB RMS).

Peak SPLs

Average Peak SPLs reported for projects ranged from approximately 180 dB to 191 dB. The per-pile 90% cumulative probability value of 188 dB was chosen as the recommended proxy peak SPL value. This value is below the peak threshold for the onset of injury in fish (206 dB). Table 2-1 summarizes the values from the two projects.

SEL

Sound exposure levels were only reported for six of the eight projects reviewed, with per-pile values ranging from 158 dB to 167 dB (Table 2-1). The pile SEL average over all projects of 164 dB was considered representative of a conservative average SEL source value for 24-inch piles.

*Proxy Source Sound Levels and Bubble Curtain Attenuation
September 2014*

2.1.4 Vibratory Pile Driving Source Values

NMFS has established non-impulsive injury thresholds (180 dB RMS for cetaceans, 190 dB RMS for pinnipeds) and a disturbance threshold (120 dB RMS) for marine mammals. Vibratory driving is considered a non-impulsive sound source. Attachment 3 in Appendix A contains a list of vibratory projects and derived proxy source values we reviewed in order to calculate how far sound from vibratory driving exceeds the thresholds discussed in Section 1.2.1. Table 2-2 presents the summary of vibratory pile driving data from the projects reviewed. Due to the similarity in levels across multiple projects, 16-inch and 24-inch piles were considered together, and 30-inch and 36-inch piles were considered together.

**Table 2-2. Vibratory Pile Driving SPLs.*
Recommended Proxy Source SPLs at 10 m Bolded.**

Pile Size and Type	Number of Projects Considered	Range of Average RMS dB re 1μPa @ 10 meters	Reasonable Source Level dB re 1μPa dB @ 10 meters
Timber			
12-inch	1	152-155 ¹	153²
Steel Pipe			
16-inch and 24-inch	4	Bangor 153-162 All projects 159-162	161
30-inch and 36-inch	7	Bangor 166 All projects 159-172	NBK Bangor 166 Other Puget Sound Locations 167
Steel Sheet			
24-inch	3	160-163**	163

¹See Attachment 3 for projects reviewed.
²Data reported at 16m, converted to equivalent range of 10m using $15\log_{10}[16/10]$ range correction factor
*Recommended values for 10 meters unless otherwise indicated.
**Highest value for pile; value includes some averages from only top or bottom depth measurements and one from top and bottom averaged.

2.1.4.1 Timber Pile Vibratory Driving Source Values

Only one timber pile study is available and only for noise measurements taken during extraction of one 12-inch diameter pile (see Attachment 3 in Appendix A). The highest RMS value was 152 dB measured at 16 meters (Table 2-2), with an average value of 150 dB reported at 16 meters.

2.1.4.2 24-Inch Diameter Steel Pipe Pile Vibratory Driving Source Values

Two projects in Washington and one in California were reviewed for 24-inch diameter steel pipe piles. The Washington marine projects at the Friday Harbor Terminal and NBK, Bangor waterfront, only measured one pile each, but reported similar sound levels of 162 dB RMS and 159 dB RMS (range 157 dB to 160 dB), respectively (see Attachment 3 in Appendix A). Because only two piles were measured in Washington, the California project was also included in the analysis. The California project was located in a coastal bay and reported a “typical” value

*Proxy Source Sound Levels and Bubble Curtain Attenuation
September 2014*

of 160 dB RMS with a range 158 to 178 dB RMS for two piles where vibratory levels were measured. Caltrans summarized the project's RMS level as 170 dB RMS (Table I.2-3 in Caltrans 2012), although most levels observed were nominally 160 dB. A fourth project at NBK, Bangor drove 16-inch hollow steel piles, and measured levels similar to those for the 24-inch piles; therefore these data were included in the 24-inch analyses. Although the data set is limited to these four projects, close agreement of the levels (average project values from 159 to 162 dB at 10 meters) indicate similar vibratory conditions at NBK, Bangor. The highest project average of 162 dB was selected as the most reasonable proxy for 24-inch steel pipe piles. This number is higher than the data from the Bangor Test Pile Program and is therefore conservative.

2.1.4.3 30-inch and 36-inch Diameter Steel Pipe Pile Vibratory Driving Source Values

Five projects were reviewed for 30-inch diameter piles and four projects were reviewed for 36-inch diameter piles, with a total sample set of seven projects since some projects used both 30-inch and 36-inch piles. All projects were located in Puget Sound. Because the 30-inch diameter pile average RMS measurements overlap (164 dB, 168 dB, 170 dB, and 171 dB) the measurements reported for 36-inch diameter piles at the Bangor waterfront, the Edmonds and Anacortes ferry terminals range (159 dB, 162.5 dB, 169 dB, respectively), the 30-inch and 36-inch pile data were combined for the review.

We reviewed data from Bangor waterfront projects for 30 and 36-inch piles, which were based on a large sample size relative to other projects (n=68 piles, Attachment 3). RMS vibratory average levels were consistently lower at Bangor than other Puget Sound locations. We recommend using the site-specific data average RMS level for modeling vibratory pile driving at NBK, Bangor, that is, the recommended RMS vibratory installation proxy source value 30-inch to 36-inch diameter piles is 166 dB. Because site specific data is unavailable for all other Navy installations in Puget Sound, we recommend the more conservative proxy value of 167 dB for other Puget Sound Navy sites, which represents the average level for all Puget Sound locations excluding NBK, Bangor for both 30-inch and 36-inch piles.

Table 2-2 summarizes the ranges for the combined size category. Table 2-2 presents reasonable proxy values expected from reviewing values taken from the highest average project SPL for all projects reviewed.

2.1.4.4 24-Inch Steel Sheet Pile Vibratory Driving Source Values

Sound levels for vibratory sheet pile driving were reported for three Caltrans projects at the Port of Oakland in San Francisco Bay (see Attachment 3 in Appendix A). No data were found for sheet pile driving in Puget Sound. RMS values were only available for one pile at one project and this had an average RMS value of 163 dB. The second project reported 1 sec SEL levels at 10 m for 5 vibratory driven sheet piles. The average per pile SEL ranged from 157 to 160 dB based on the average top and bottom depth measurements. Caltrans also reported 162 dB RMS as the highest average for a single depth for the same project. The third project reported 163 dB RMS (Table I.2-3 in Caltrans 2012). Caltrans reported 160 dB RMS as the typical sheet pile value for all three projects (Table I.2-2 in Caltrans 2012). Based on the levels from the three projects, 163 dB RMS value was used as a conservative proxy value.

*Proxy Source Sound Levels and Bubble Curtain Attenuation
September 2014*

2.2 Airborne Pile Driving Source Values

NMFS has established an in-air noise disturbance threshold of 90 dB RMS re 20 μ Pa (unweighted) for harbor seals, and 100 dB RMS re 20 μ Pa (unweighted) for all other pinnipeds. Attachment 4 and Attachment 5 in Appendix A list the impact and vibratory pile driving projects, respectively, that were reviewed. Most projects report A-weighted levels. For this review, however, only unweighted data were considered. Two airborne noise values are presented for most projects: L_{max} and L_{eq} . The L_{max} is the instantaneous highest sound level measured during a specified period, or maximum noise level. It typically represents a short duration average, usually 35 milliseconds. Because impact pile driving is an impulsive sound with short durations, the signal is most appropriately characterized by the L_{max} value. Proxy values for impact driving are found in Attachment 4.

The L_{eq} is the equivalent steady-state noise level in a stated period of time. It contains the same acoustic energy as the time-varying noise level during the same period. L_{eq} is primarily used for a steadier, non-impulsive noise. The L_{eq} , which averages the source over a period of time, is a better descriptor for non-impulsive sound like vibratory pile driving. These values are listed in Attachment 5 for vibratory pile driving and Table 2-3 summarizes L_{max} and L_{eq} data.

Review of the available literature provided two unweighted L_{max} levels, both from the NBK Bangor Test Pile Program. A maximum level of 112 dB re 20 μ Pa was measured for 36-inch piles ($n=9$ piles), at the de facto measurement distance of 50 feet, and was therefore chosen as a conservative proxy value for piles 30 and 36-inches. A maximum level of 110 dB was measured for a single 24-inch pile, and was selected as the most representative value for modeling analysis.

Unweighted RMS L_{eq} values of 88 dB were obtained from vibratory pile driving 18-inch steel pipe piles. A single 30-second measurement was made for 24-inch piles during the Test Pile Program at NBK, Bangor. These data fit the overall trend of smaller and larger pile sizes. The limited data set for 24-inch steel pipe, supports a reasonable representative proxy value of 92 dB.

Limited data were available for 30 and 36-inch piles. One 30-inch pile measured at the Keystone ferry terminal fell within the range of 36-inch piles measured at Bangor, although the average value for this was 2 dB above the average value measured at Bangor. Levels measured at Vashon Island ferry terminal were made using A-weighted filters, and adjusted for range and filter type. Even after corrections were made observed levels were significantly lower than other sites, thus these data were not considered for further analysis. We therefore selected 95 dB (unweighted) as the representative L_{eq} average proxy value for 30-inch and 36-inch piles. Based on the limited data available, the RMS L_{eq} value for 18-inch steel pipe piles was chosen as the proxy source value for vibratory installation or removal of piles less than 24-inch regardless of pile type. The RMS L_{eq} value for 24-inch steel pipe piles was chosen as the best estimate for 24-inch sheet piles.

*Proxy Source Sound Levels and Bubble Curtain Attenuation
September 2014*

Table 2-3. Summary of Airborne Source Levels with Recommended Proxy Source Values Bolded¹

Pile Type	Size (diameter in inches)	Installation Method	
		Impact RMS L _{max} (Unweighted) Impact	Vibratory RMS L _{eq} (Unweighted) Vibratory
Timber	12-inch	—	—
Steel Pipe	18-inch	—	88
	24-inch	110¹	92²
	30-inch	—	95
	36-inch	112	95
Steel Sheet	24-inch	—	—

Notes: All values relative to 20μPa and at 15 m (50 ft) from pile.
¹See Attachments 4 and 5 in Appendix A for projects reviewed. ²Limited data set

*Proxy Source Sound Levels and Bubble Curtain Attenuation
September 2014*

THIS PAGE INTENTIONALLY LEFT BLANK

*Proxy Source Sound Levels and Bubble Curtain Attenuation
September 2014*

3 Evaluation of Potential Bubble Curtain Sound Attenuation

To reduce noise produced from impact pile driving, bubble curtains are used around the pile as it is driven and can be confined or unconfined. Confined bubble curtains place a fabric shroud or rigid sleeve around the pile to hold air bubbles near the pile, ensuring they are not washed away by currents or tidal action. They are recommended when water velocities are 0.6 meters (1.6 feet per second) or greater (NMFS 2008).

None of the project locations at Naval Base Kitsap, Naval Magazine Indian Island, Naval Station Everett, Naval Air Station Whidbey Island Seaplane Base, Manchester Fuel Depot are in high current areas; therefore, this discussion focuses on unconfined bubble curtains. Unconfined bubble curtains involve use of pressurized air injected from an air compressor on the pile driving barge through small holes in aluminum or PVC pipe around the driven pile. Noise reduction results from unconfined bubble curtains were reported from several projects. There was a wide range of effectiveness from very little measurable attenuation in some cases to high attenuation in others (Illingworth and Rodkin 2001; WSDOT 2013). Caltrans (2009) summarized the application of unconfined bubble curtain systems in various California projects and reported from 1 to 5 dB of attenuation in high current situations and 5 to 15 dB of attenuation in low current situations. Application of a multiple-ring system in a deep water, strong current setting (Benicia-Martinez Bridge) achieved 15 to more than 30 dB attenuation when driving 8-foot diameter piles. Because some sound pressure waves also propagate from the pile through the substrate and reenter the water column, not all sound pressure waves will be attenuated by a bubble curtain (Reinhardt and Dahl 2011). Variability in bubble curtain performance when measured at various distances out from the pile is likely explained by the sound propagation properties of various substrates, the localized bathymetry, as well as variances in embedment depths of piles.

3.1 Noise Attenuation Assumptions for Acoustic Modeling

The Navy conducted a Test Pile Program at Naval Base Kitsap, Bangor where attenuation of an unconfined bubble curtain was measured when driving 24-inch, 36-inch, and 48-inch steel pipe piles.⁵ It should be noted that attenuation measurements were not conducted at EHW-2, and are therefore excluded from calculations herein.⁶ Calculations for attenuation were made by calculating the amplitude ratio reduction of the pressure metric with the bubble curtain on compared to the bubble curtain off measurements, and then converting the ratio into a decibel value. Weighted values are computed for each metric based on the number of strikes measured. All measurements were taken from the nominal 10 meter de facto distance from the pile.

⁵ Illingworth and Rodkin, 2012

⁶ Attenuated measurements from pile installation at EHW-2 in 2012 were similar to nonattenuated measurements from test piles installed in 2011 at the project site, indicating a nonfunctional bubble curtain. Most commonly observed problems reported for non-functional bubble curtains reflect inadequate air-flow or poor seating of the bottom of the curtain at the water-sediment boundary resulting in a non-attenuated sound path.

*Proxy Source Sound Levels and Bubble Curtain Attenuation
September 2014*

The sole 24-inch pile in this project was struck a total of 3 times with the bubble curtain turned on. Therefore, the results are unlikely to be indicative of values that would be obtained on this site with more extensive measurements and are not considered further in this review. Piles for which fewer than 10 strikes were measured were also excluded. It is recommended to acquire a larger 24-inch data set to obtain a better synopsis for these results.

For 36-inch piles the weighted average peak, RMS, and SEL reduction with use of the bubble curtain was 10 dB, where the averages of all bubble-on and bubble-off data were compared (see Table 3-1 below). This data set represents 2 piles, for a total of 165 strikes. For 48-inch piles, the weighted average pressure reduction for RMS, peak, and SEL with use of a bubble curtain was 8 dB, representing 138 strikes. Across all piles (36" and 48") and all metrics (RMS, peak, SEL), the weighted average attenuation was 9 dB.

Table 3-1. Reduction (dB) in Weighted Average Noise Values for Impact Pile Driving of Steel Piles with a Bubble Curtain, Measured at 10 meters averaging mid-depth and deep-depth data. Measurements obtained during Bangor Naval Base Test Pile Program

Pile Size	Attenuation Level (RMS)		Attenuation Level (Peak)		Attenuation Level (SEL)		Weighted Average (all metrics)
	Weighted	Unweighted	Weighted	Unweighted	Weighted	Unweighted	
36-inch	9	9	11	11	10	10	10
48-inch	7	7	9	9	7	7	8
Overall weighted average							9

Source: Illingworth & Rodkin 2012

We also reviewed unconfined bubble curtain attenuation rates from available reports from projects in Washington, California, and Oregon that impact drove steel pipe piles up to 48-inches in diameter. Table 3-2 contains a summary of the attenuation levels reported. Several studies were reviewed, but not included in the summary because they were not considered representative. Excluded studies were:

- Willamette River Bridge Project (Caltrans 2012). Bubble curtain was poorly designed and deployed in a river with a high current. No RMS SPLs reported.
- South Umpqua River (Caltrans 2012). Current conditions resulted in little coverage of piles by bubble curtain. No RMS SPLs reported.
- Ten Mile River Bridge Project (Caltrans 2012). 30-inch piles driven with bubble curtain, but inside of cofferdam.

Of the remaining studies reviewed, significant variability in attenuation occurred; however, an average of at least 8 dB of peak SPL attenuation was achieved on ten of the twelve projects (Table 3-2). Some of the lower attenuation levels reported were attributed to the bottom ring not

*Proxy Source Sound Levels and Bubble Curtain Attenuation
September 2014*

scated on the substrate, poor airflow, or currents that resulted in an uneven distribution of bubbles (WSDOT 2005a, WSDOT 2005b, Caltrans 2012).

Table 3-2. Summary of Attenuation Levels Reported with Unconfined Bubble Curtains During Impact Driving of Steel Pipe Piles up to 40-inches Diameter

Project/Location	Steel Pipe Pile Diameter	Range (dB)	Mean Peak dB re 1µPa @ 10 m	Standard Deviation (dB)
Friday Harbor Ferry Terminal Restoration/ San Juan Island marine waters, WA ¹	24-inch 30-inch	0-5	2	2.2
Bainbridge Island Ferry Terminal Preservation/ Puget Sound marine waters, WA ¹	24-inch	3-14	7	4.7
Cape Disappointment Boat Launch Facility, Wave Barrier Project/ Columbia River, Ilwaco, WA ¹	12-inch (n=5*)	6-17	11	4.9
Mukilteo Ferry Terminal Test Pile/Puget Sound marine waters, WA ¹	36-inch (n=2)	7-22	15	10.6
Anacortes Ferry Terminal Dolphin Replacement/Puget Sound marine waters, WA ¹	36-inch (n=7)	3-11	8	3.1
SR 520 Test Pile Project/Lake Washington/Portage Bay (freshwater), WA ^{1,2}	24-inch (n=4) 30-inch (n=2)	3-32	20	11.1
Columbia River Crossing Test Pile Program/Columbia River, WA/OR ³	24-inch (n=1)	--	10	--
Tesoro's Amoco Wharf/San Francisco Bay, Martinez, CA ²	24-inch (n=18 battered and n=18 vertical)	--	~10 dB (not well seated, stated capable of up to 15 dB and strong currents present at times and poor positioning on some piles)*	--
Deep Water-longue Point Facility Pier Repairs/Columbia River, Astoria, OR ²	24-inch (n = 10)	5-22	14	--
Portland-Milwaukee Light Rail Project/Willamette River, Portland, OR ²	24-inch (n=5)	8-27	--	--
Bay Ship and Yacht Dock/San Francisco Bay, Alameda, CA ²	40-inch (n = 2)	--	~10-15 (Not installed at the substrate at start of drive. Performance from part of drive when bubble curtain properly situated).*	--
Richmond-San Rafael Bridge Project/San Francisco Bay, CA ²	30-inch (n=2)	--	9	--

Sources: ¹WSDOT 2013, Also, see individual report references for WSDOT; ²Caltrans 2012; ³CRC 2011.

*As reported by Illingworth and Rodkin in Caltrans 2012.

*Proxy Source Sound Levels and Bubble Curtain Attenuation
September 2014*

In summary, bubble curtain performance is highly variable. Effectiveness depends on the system design and on-site conditions such as water depth, water current velocity, substrate and underlying geology. Installation and how well the curtain is seated on the substrate at the bottom are also important factors. To avoid loss of attenuation from design and implementation errors, our project has specific bubble curtain design specifications, including testing requirements for air pressure and flow prior to initial impact hammer use, and a requirement for placement on the substrate.

While bubble curtain performance is variable, we believe that, based on information from the Bangor Naval Base Test Pile Program, an average peak SPL⁷ reduction of 8 dB to 10 dB at 10 meters would be an achievable level of attenuation for steel pipe piles of 36- and 48-inches in diameter. However, to be more conservative for 48 inch piles, use of 7 dB for both RMS and SEL metrics is justified.

⁷ For most of the studies reviewed, Peak SPLs were the only metric reported.

*Proxy Source Sound Levels and Bubble Curtain Attenuation
September 2014*

4 References

- 1) Caltrans (California Department of Transportation). 2009. Technical Guidance for Assessment and Mitigation of the Hydroacoustic Effects of Pile Driving on Fish. Prepared by ICF Jones & Stokes, Sacramento, CA and Illingworth & Rodkin, Inc. Petaluma, CA. February 2009.
- 2) CalTrans. 2012. Compendium of Pile Driving Sound Data. Sacramento, California. Updated October 2012, posted March 20, 2013. Available at http://www.dot.ca.gov/hq/env/bio/fisheries_bioacoustics.htm.
- 3) CRC (Columbia River Crossing). 2011. Columbia River Crossing test pile project hydroacoustic monitoring final report. Technical report prepared by David Evans and Associates, Inc. July 2011. Available at http://www.columbiarivercrossing.org/filelibrary/technicalreports/CRC_Pile_R.
- 4) Illingworth and Rodkin, Inc. 2001. Noise and vibration measurements associated with the pile installation demonstration project for the San Francisco-Oakland Bay Bridge East Span, Final Data Report, Task Order 2, Contract No. 43A0063.
- 5) Longmuir, C. and T. Lively. 2001. Bubble curtain systems for use during marine pile driving. Produced by Fraser River Pile & Dredge, Ltd.
- 6) MacGillivray, Al, Ziegler, E. and J. Laughlin. 2007. Underwater acoustic measurements from Washington State Ferries 2006 Mukilteo ferry terminal test pile project. Technical report prepared by JASCO Research, Ltd for Washington State Ferries and Washington State Department of Transportation, 27 pp. Available at <http://www.wsdot.wa.gov/environment/air/piledrivigreports.htm>.
- 7) Navy (Department of the Navy). 2012. Naval Base Kitsap at Bangor test pile program acoustic monitoring report. Prepared by Illingworth and Rodkin, Inc. for the U.S. Navy, April 15, 2012.
- 8) Navy (Department of the Navy). 2013. Naval Base Kitsap, Bangor Explosives Handling Wharf-2 acoustic monitoring report. Prepared by Illingworth and Rodkin, Inc. for the U.S. Navy.

*Proxy Source Sound Levels and Bubble Curtain Attenuation
September 2014*

- 9) Reinhall, P.G. and P.H. Dahl. 2011. Underwater Mach wave radiation from impact pile driving; theory and observation. *Journal of the Acoustical Society of America* 130:120-1216.
- 10) NMFS (National Marine Fisheries Service). 2008. Programmatic Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation for Revisions to Standard Local Operating Procedures for Endangered Species to Administer Maintenance or Improvement of Road, Culvert, Bridge and Utility Line Actions Authorized or Carried Out by the U.S. Army Corps of Engineers in Oregon (SLOPES IV Roads, Culverts, Bridges and Utility Lines). National Marine Fisheries Service, Northwest Region, August 13, 2008.
- 11) WSDOT (Washington Department of Transportation). 2005a. Underwater sound levels associated with restoration of the Friday Harbor Ferry Terminal. May 2005. Available at <http://www.wsdot.wa.gov/environment/air/piledrivingreports.htm>.
- 12) WSDOT. 2005b. Underwater sound levels associated with pile driving at the Bainbridge Island ferry terminal preservation project. November 2005. Available at <http://www.wsdot.wa.gov/environment/air/piledrivingreports.htm>.
- 13) WSDOT. 2006. Underwater sound levels associated with pile driving at the Cape Disappointment boat launch facility, wave barrier project. March 2006. Available at <http://www.wsdot.wa.gov/environment/air/piledrivingreports.htm>.
- 14) WSDOT. 2007. Underwater sound levels associated with pile driving during the Anacortes ferry terminal dolphin replacement project. April 2007. Available at <http://www.wsdot.wa.gov/environment/air/piledrivingreports.htm>.
- 15) WSDOT. 2010. Underwater sound levels associated with driving steel piles for the State Route 520 bridge replacement and HOV project pile installation test program. Prepared by Illingworth and Rodkin, Inc. Available at <http://www.wsdot.wa.gov/environment/air/piledrivingreports.htm>.
- 16) WSDOT. 2013. Biological Assessment Preparation Advanced Training Manual Version 2013 (Chapter 7 – updated February 2012). Available at <http://www.wsdot.wa.gov/environment/biology/ba/baguidance.htm>.

*Proxy Source Sound Levels and Bubble Curtain Attenuation
September 2014*

Appendix A: Studies Reviewed for Evaluation of Underwater Pile Driving Sound

*Proxy Source Sound Levels and Bubble Curtain Attenuation
September 2014*

THIS PAGE INTENTIONALLY LEFT BLANK

September 2014

Appendix A

Appendix A: Studies Reviewed for Evaluation of Underwater Pile Driving Sound

Attachment 1. Impact Pile Driving SPLs from Studies Utilizing Steel Pipe/CISS Piles.

Bolded values were considered for proxy source levels.						
Project	Location	Number of Piles Measured	Hammer Type	Water Depth (m)	Distance (m)	RMS (dB re 1 µPa)
24-inch Steel Pipe						
Bainbridge Island Ferry Terminal ¹	Bainbridge Island, WA	n=5	Diesel	2.1-3.4	10	Weighted Ave 195
Friday Harbor Ferry Terminal ²	Friday Harbor, WA	n=5	Diesel, pneumatic, hydraulic	10-14.3* , **	10	Weighted Ave 189
Bangor Test Pile Program ³	Bangor Naval Base, WA	n=1	Impact	4.6	10	Ave range 181-193
Conoco/Phillips Dock ⁴	Rodeo, San Francisco Bay, CA	n=2	Diesel	>5	10	Max 180
Tesoro's Amoco Wharf ⁵	San Francisco Bay, Martinez, CA	(1 st pile with poor attenuation)	Diesel	10-15	10	Range 188-189
Deep Water-Tongue Point Facility Pier Repairs ⁶	Mouth of Columbia River, Astoria, OR	n=10	Diesel	unknown	10	189
30-inch Steel Pipe						
Richmond-San Rafael Bridge, CALTRANS ⁷	San Rafael, CA	n=4	Diesel	4-5	10	Typical 190 (max=192)
Eagle Harbor Maintenance Facility ⁵	Bainbridge Island, WA	n=3	Diesel	10	10 (n=2) 16 (n=1)	Weighted Ave 192
Friday Harbor Ferry Terminal #8 ²	Friday Harbor, WA	n=1	Diesel	10.4*	10	Ave range 203-204
						211
						187
						SEL (dB re 1 µPa ² /s)

A-1

September 2014

Appendix A

Project	Location	Number of Piles Measured	Hammer Type	Water Depth (m)	Distance (m)	RMS (dB re 1 μPa)	Peak (dB re 1 μPa)	SEL (dB re 1 μPa ²)
Vashon Ferry Terminal ^{6,8}	Vashon Island, WA	n=3	Diesel	11-12	10	Weighted Ave 195 Ave range 192-196	Weighted Ave 215 Ave range 212-217	Weighted Ave 186 Ave range 182-187
36-inch Steel Pipe ^{7,8,9}	Humboldt Bay—Eureka, CA	CJSS II=1, restrictors	Diesel	10	10-	193 (max)	210 (max)	183 (max)
Mukilteo Test Piles ⁷	Mukilteo, WA	n=2	Diesel	7.3	10	Weighted Ave 190 Ave range 187-191	Weighted Ave 205 Ave range 202-207	Weighted Ave 183 Ave range 180-184
Anacortes Ferry ⁸	Anacortes, WA	n=7	Impact	12.8	10	Weighted Ave 192 Ave range 189-193	Weighted Ave 209 Ave range 205-211	Weighted Ave 185 Ave range 182-186
Bangor Test Pile Program ¹⁰	Bangor Naval Base, WA	n=4	Diesel	13.7-26.8	10	Weighted Ave 194 Ave range 185-196	— ^a	Weighted Ave 181 Ave range 173-183

Notes: Ave = Average

* Substrate was sandy silt/clay
 ** Substrate was sandy silt/rock

*** Single strike SEL not reported
 **** ETIW-2 project at Bangor waterfront measured 24- and 36-inch piles; however, all piles were attenuated so they are not included in the table.

24-inch (n=41) averages were: average peak = 179 (s.d. 9.58), average RMS = 179 (s.d.=24.10), SEL = 170 dB (s.d.=7.48). 36-inch pile (n=26): average peak=205 (s.d.=4.33), average RMS = 188 (s.d.=5.01), average SEL=175 (s.d.= 5.11) (Navy 2013).

† 24-inch piles were not hit very hard, so these are not representative of the levels that may occur in the future or elsewhere.
 # distance to pile ranged above and below 10m. Data normalized to 10m using $15\log_{10}(\text{range}/10\text{m})$ relationship.

^a Average peak values not reported.

Sources:

¹ WSDOT 2005a
² WSDOT 2005b

³ Navy 2012

⁴ Caltrans 2012

⁵ JASCO Research, 2005, WSDOT 2008

⁶ WSDOT 2010b

⁷ WSDOT 2007a

⁸ WSDOT 2007b

September 2014

Appendix A

Attachment 2. Impact Pile Driving SPLs from Studies Utilizing Concrete Piles.

Bolded values were considered for proxy source levels.

Project	Location	Number of Piles Measured	Hammer Type	Water Depth (m)	Distance (m)	RMS (dB re 1 µPa)	Peak (dB re 1 µPa)	SEL (dB re 1 µPa ² s)
16-inch and 18-inch Piles								
Pier 2 Concord/NWS ¹ (16-inch square)	Concord, CA	n=5	Drop Steam Powered	7	10	Ave 171 Ave range 167-173	Ave max 133 Ave max range 182-184 Max 184	N/A
Berkeley Marina (2007) ¹ (18-inch octagonal)	Berkeley, CA	n=1	Diesel	2-3	10	Ave 159 Ave range 155-167	Ave max 172 Ave range 172-181 Max 181	Ave 155
Berkeley Marina (2009) ¹ (18-inch octagonal)	Berkeley, CA	n=3	Diesel	2-3	10	Ave 169 Ave range 165-178	Ave max 189 Ave range 184-192 Max 192	Ave 159
24-inch Piles								
Mukilteo Ferry Terminal ² (octagonal)	Mukilteo, WA	n=1	Diesel	7-8	10	Ave 170 (single pile)	Ave max 134 Single pile	Ave 159 dB Range 159-170
Airports Pier 9 ³ (octagonal)	Benicia, CA	Not provided	Diesel	3-7	10	Ave 170 Range 168-172	Ave max 134 Range 180-192 Max 192	N/A
Pier 40 Marina ¹ (square)	San Francisco, CA	n=7	Diesel	3-4	10	Ave 171 Ave range 167-174	Ave max 184 Ave range 180-186 Max 186	N/A
Berth 22 Port of Oakland ⁴ (December 2004) ¹ (octagonal)	Oakland, CA	Several	Diesel (dependent on row)	0-15 (mostly)	10	Ave 176 ^{**} Ave range*** 171-179 Max 181	Ave max 189 ^{**} Ave range*** 171-183-191 Max 193	Ave 165 ^{**} Ave range*** 162-167
Berth 22 Port of Oakland ⁴ (August 2004) ¹ (octagonal)	Oakland, CA	n=4	Diesel	10-13	10	Ave 175 Ave range during loudest part of drive 174-176 Max 178	Ave max 187 Ave max range during loudest part of drive 186-188 Max 190	Ave 165 Ave range during loudest part of drive 164-166 Max 168
Berth 32 Port of Oakland (2005) ¹ (octagonal)	Oakland, CA	n=2	Diesel	3-7	10	Ave 174 Ave range 172-176	Ave max 186 Ave range 185-187 Max 187	Ave 163 Ave range 158-165

A-3

September 2014

Appendix A

Project	Location	Number of Piles Measured	Hammer Type	Water Depth (m)	Distance (m)	RMS (dB re 1 μ Pa)	Peak (dB re 1 μ Pa)	SEL (dB re 1 μ Pa ² s)
Berth 32 Port of Oakland (2004) ¹ (octagonal)	Oakland, CA	n=5	Diesel	>10	10	Ave 173 Ave range 173-174	Ave max 185 Ave max range 184-185 Max 185	Ave 162 Ave range 161-163
Humboldt State University Floating Dock*** ² (octagonal)	Humboldt Bay, Eureka, CA	n=3	Diesel	3-4	10	Ave 157 Ave range 156-158	Ave max 179 Ave max range 176-179 Max 179	Ave 148 Ave range 142-151

Notes: Ave = Average

* For piles with fuel setting on high, no jetting.

** File with fuel setting on low, no jetting.

*** Average for row, not pile. Sound levels varied by depth. Only in-water sound levels reported in table (in parentheses values from Row A-D in Table 1.5-4 in Caltrans 2013).

Sources:¹ Caltrans 2012² WSDOT 2007a

September 2014

Appendix A

Attachment 3. Vibratory Pile Driving SPLs from Marine Projects.
Bolded values were considered for proxy source levels.

Project	Location	Number of Piles Measured	Water Depth (meters)	Distance (meters)	Mean RMS* dB re 1 µPa
12-inch Timber					
Port Townsend Dolphin Timber Pile Removal ¹	Port Townsend, WA	n=1	—	16	Average 150 Range 149-152
13-inch Steel Pipe					
Mad River Slough Pipeline Construction ²	Mad River Slough, Arcata, CA	n=3	4.5-5.5	10	155
16-inch Steel Pipe					
EHW-1 ³	Bangor, WA	n=8	9-12	10	162 Ave range 153-168
24-inch Steel Pipe					
Friday Harbor ⁴	Friday Harbor, WA	n=1	2.6	10	162
Trinidad Pier Reconstruction ²	Trinidad Bay, Humboldt County, CA	n=2	15.2	10	Typical 160 range 158-178
Bangor Test Pile Program ⁵	Bangor Naval Base, WA	n=2 (1 pile vibed in and out)	4.6	10	160 Ave range 157-160**
30-inch Steel Pipe					
Edmonds ⁶	Edmonds, WA	n=2	6.4	10	165-166
Keystone Ferry Terminal ⁷	Coupeville, WA	n=4	~9.4	10 11 6 11	Per pile values due to different distances (165 176 176 165) Ave 173 Ave range 165-176
Vashon Ferry Terminal ⁸	Vashon Island, WA	n=4	<6	11-16	167 Ave range 160 - 169
Port Townsend Test Pile Project ^{9, 10}	Port Townsend, WA	n=1	8.8	10	170 Ave range 164-174
EHW-1 ³	Bangor, WA	n=35	9-12	10	168 Ave range 155-174
36-inch Steel Pipe					
Edmonds Ferry Terminal ⁶	Edmonds, WA	n=2	5.8	11	Ave range 162-163
Anacortes Ferry Terminal ¹¹	Anacortes, WA	n=2	12.7	11	Ave range 168-170
Port Townsend Test Pile Project ^{9, 10}	Port Townsend, WA	n=1	9.5	10	172 159-177
Bangor Test Pile Program ⁵	Bangor Naval Base, WA	n=~33 -33	13.7-26.8	10	164 ** Ave range 154-169
24-inch AZ25 Steel Sheet					
Berth 23, Port of Oakland ²	Oakland, CA	n=1	~12-14	10	163***
Berth 30, Port of Oakland ²	Oakland, CA	n = 5	~12	10	1-sec SEL**** = 159 Ave range 157-160 (162 highest ave from bottom depth)
Berth 35/37, Port of Oakland ²	Oakland, CA	=	15	10	163

September 2014

Appendix A

Notes: Ave = Average.

*WSDOT typically reports average of 30-second RMS values calculated over the duration of a drive.

** Average of all pile driving events.

***Involved only stabbing. Average reported by Caltrans Table I-1.2-3

****RMS SPLs were not reported, but would be similar to SEL for 1 second. Average top and bottom depths

Sources:

¹ WSDOT 2011a² Caltrans 2012³ Miner 2012⁴ WSDOT 2010a⁵ Navy 2012⁶ WSDOT 2011b⁷ WSDOT 2010c⁸ WSDOT 2010d⁹ WSDOT 2010e¹⁰ Laughlin 2010¹¹ WSDOT 2012

* Sound attenuation used - water jetting and cushion blocks.

** Water jetting data were excluded from analysis data set

¹ Caltrans 2012**Attachment 4. Impact Pile Driving L_{max} Airborne SPL Studies.****Bolded projects were considered for proxy source levels.**

Project	Location	Number of Piles Measured	Distance (meters/feet)	L _{max} dB re 20 µPa
12-inch Steel Pipe				
Cape Disappointment Boat Launch Facility, Wave Barrier Project ¹	Columbia River, Astoria, OR	1 at 50 m	50 m/164 ft	89 A-weighted
24-inch Steel Pipe				
Bangor Test Pile Program	Bangor Naval Base, WA	1	15.2 m/50 ft 121.9 m/400 ft	110 dB (109dBA) 95 dB (93 dBA)
SR 520 Bridge Replacement Test Pile ²	Portage Bay, Seattle, WA	2	11-15 m/ 36-49 ft	95-100 dBA
30-inch Steel Pipe				
Friday Harbor Ferry Terminal Restoration ³	San Juan Island Area, Friday Harbor, WA	1	49 m / 160 ft	---
SR 520 Bridge Replacement Test Pile ⁴	Union Bay, Lake Washington, Seattle, WA	4	11-15 m/ 36-49 ft	103-106 dBA
36-inch Steel Pipe				
Bangor Test Pile Program⁴	Bangor Naval Base, WA	--	15 m/ 50 ft	109 dB (sd=2.58) Range 106-112 dB

Notes: All values unweighted unless indicated. Only unweighted values were considered for proxy values.

Sources:

¹ WSDOT 2006² WSDOT 2010f³ WSDOT 2005b⁴ Navy 2012

September 2014

Appendix A

Attachment 5. Vibratory Pile Driving L_{eq} Airborne SPL Studies.
Bolded projects were considered for proxy source levels.

Project	Location	Number of Piles Measured	Distance (meters/feet)	Average RMS L _{eq} dB re 20 µPa*	Average RMS L _{eq} dBA re 20 µPa**
18-inch Steel Pipe					
Wahkiakum Ferry Terminal¹	Columbia River, WA	1	15.2 m/50 ft*	87.5	
24-inch Steel Pipe					
Bangor Test Pile Program	Bangor Naval Base, WA	1	15.2 m/50 ft 121.9 m/400 ft	92 78 dB	85 72
SR 520 Bridge Replacement Test Pile ²	Portage Bay, Seattle, WA	1	11 m/36 ft	88 dBA	---
30-inch Steel Pipe					
Keystone Ferry Terminal³	Puget Sound, WA	1	15.2 m/50 ft*	95 Range 93-96	
Vashon Ferry Terminal Test Pile Project ^{1,3}	Puget Sound, Vashon Island, WA	2	15.2 m/50 ft*	-83-85**	-77-80 dBA*
36-inch Steel Pipe					
Bangor Test Pile Program⁴	Bangor Naval Base, WA	—	15 m/50 ft	93 (sd =3.08) Range 89-102	

Notes: All values unweighted unless indicated.

* Sound pressure levels standardized to 50 ft range. Measurements made at 11 meters

**Converted to C-weighted from A-weighted measurements to approximate unweighted sound level, reported at a distance of 26 to 36 feet.

Sources:

¹ WSDOT 2010g² WSDOT 2010f³ WSDOT 2010d⁴ Navy 2012

September 2014

*Appendix A***References**

- 1) CalTrans. 2012. Compendium of Pile Driving Sound Data. Sacramento, California. Updated October 2012, posted March 20, 2013. Available at http://www.dot.ca.gov/hq/env/bio/fisheries_bioacoustics.htm.
- 2) Illingworth and Rodkin, Inc. 2001. Noise and Vibration Measurements Associated with the Pile Installation Demonstration Project for the San Francisco-Oakland Bay Bridge East Span, Chapter 4. Prepared by Illingworth and Rodkin, Petaluma, CA. Prepared for the California Department of Transportation, Sacramento, CA.
- 3) JASCO Research. 2005. Sound pressure and particle velocity measurements from marine pile driving at Eagle Harbor maintenance facility, Bainbridge Island, WA. Prepared for Washington State Department of Transportation, November 2005. <http://www.wsdot.wa.gov/NR/rdonlyres/1F219171-FB7D-4754-AE7B-C23D7EAA28F0/0/EagleHarborMaintFacRpt.pdf>
- 4) Laughlin, J. 2010. Personal communication via email between Jim Laughlin and Rick Huey, biologist Washington State Ferries, to Jim Laughlin, WSDOT Air/Acoustics/Energy Technical Manager, regarding underwater vibratory sound levels from the Port Townsend Vibratory Test Pile project. November 15, 2010.
- 5) Minor, R. 2012. Hydroacoustic Monitoring Production Piles: PP30"X0.50" steel pipe piles, APE 200-6 vibratory driver/extractor; Falsework piles: PP16", APE 200-6 vibratory driver/extractor; Explosives Handling Wharf No. 1, October 7-27, 2011, Naval Base Kitsap, Bangor Washington. Report to Jayme Newbigging, P.E. Manson Construction and Engineering Company from Robert Miner Dynamic Testing, Inc. March 3, 2012.
- 6) Navy (U.S. Department of the Navy). 2012. Acoustic monitoring report Test Pile Program. Prepared for Naval Base Kitsap at Bangor, WA. Prepared by Illingworth and Rodkin, Inc., April 27, 2012.
- 7) WSDOT (Washington State Department of Transportation). 2005a. Underwater sound levels associated with pile driving at the Bainbridge Island Ferry Terminal preservation project. November 2005. <http://www.wsdot.wa.gov/NR/rdonlyres/8AD90843-1DF0-48B7-A398-2A2BFD851CF8/0/BainbridgeFerryTerminal.pdf>

*September 2014**Appendix A*

- 8) WSDOT 2005b. Underwater sound levels associated with restoration of the Friday Harbor Ferry Terminal. May 2005. Available at <http://www.wsdot.wa.gov/NR/rdonlyres/BCFD911C-990C-4C38-BA09-AA05145DCDB2/0/FridayHarborFerryTerminal.pdf>.
- 9) WSDOT. 2006. Washington State Parks Cape Disappointment Waver Barrier Project: Underwater sound levels associated with pile driving at the cape disappointment boat launch facility, wave barrier project. March 2006. Available at <http://www.wsdot.wa.gov/environment/air/piledrivigreports.htm>.
- 10) WSDOT. 2007a. Underwater sound levels associated with driving steel and concrete piles near the Mukilteo Ferry Terminal. March 2007. Available at <http://www.wsdot.wa.gov/NR/rdonlyres/64500C4E-3472-4D03-84DF-9F2C787A28EC/0/MukilteoFerryTermTestPileRptWSDOT.pdf>
- 11) WSDOT 2007b. Underwater sound levels associated with pile driving during the Anacortes Ferry Terminal dolphin replacement project. April 2007. Available at <http://www.wsdot.wa.gov/NR/rdonlyres/5AD837F4-0570-4631-979B-AC304DCC5FA0/0/AnacortesFerryTerminal.pdf>
- 12) WSDOT. 2008. Eagle Harbor Hydroacoustic pressure monitoring technical memorandum. May 29, 2008. Technical Memorandum prepared by Jim Laughlin for Michael Morrow and Elie Ziegler. Washington State Department of Transportation, Office of Air Quality and Noise, Seattle, Washington. May 29, 2008. Available at <http://www.wsdot.wa.gov/NR/rdonlyres/BC5980A0-377C-4356-998A-D13D87F4A8C7/0/EagleHarborMaintTechMemo.pdf>
- 13) WSDOT. 2010a. REVISED Friday Harbor Vibratory Pile Monitoring. Technical Memorandum prepared by Jim Laughlin for John Callahan and Rick Huey. Washington State Department of Transportation, Office of Air Quality and Noise, Seattle, Washington. March 15, 2010.
- 14) WSDOT. 2010b. Underwater sound levels associated with driving steel piles at the Vashon Island Ferry Terminal; Vashon Test Pile Project. April 2010. Available at <http://www.wsdot.wa.gov/NR/rdonlyres/A26D3D18-F6E5-4CE1-800B-49C475D1382F/0/VashonTestPileReport.pdf>

September 2014

Appendix A

- 15) WSDOT 2010c. Keystone Ferry Terminal – Vibratory pile monitoring. Technical Memorandum prepared by Jim Laughlin for John Callahan. Washington State Department of Transportation, Office of Air Quality and Noise, Seattle, Washington. May 4, 2010. Available at <http://www.wsdot.wa.gov/NR/rdonlyres/B42B02E3-713A-44E1-A4A6-B9DDD0C9D28A/0/KeystoneVibratoryPileReport.pdf>
- 16) WSDOT 2010d. Vashon Ferry Terminal Test Pile Project – Vibratory pile monitoring. Technical Memorandum prepared by Jim Laughlin for John Callahan and Rick Huey. Washington State Department of Transportation, Office of Air Quality and Noise, Seattle, Washington. May 4, 2010. Available at <http://www.wsdot.wa.gov/NR/rdonlyres/5868F03F-E634-4695-97D8-B7F08C0A315B/0/VashonVibratoryPileReport.pdf>
- 17) WSDOT. 2010e. Port Townsend Test Pile Project. Underwater Noise Monitoring Draft Final Report, November 10, 2010. Available at <http://www.wsdot.wa.gov/NR/rdonlyres/A3B9B492-9490-4526-88C5-2B09A3A6ACB5/0/PortTownsendTestPileRpt.pdf>
- 18) WSDOT. 2010f. Underwater sound levels associated with driving steel piles for the State Route 520 bridge replacement and HOV project pile installation test program. Prepared by Illingworth and Rodkin, Inc. Available at <http://www.wsdot.wa.gov/environment/air/piledrivigreports.htm>.
- 19) WSDOT. 2010g. Airborne Noise Measurements (A-weighted and un-weighted) during vibratory pile installation. Technical Memorandum prepared by Jim Laughlin for Sharon Rainsberry. Washington State Department of Transportation, Office of Air Quality and Noise, Seattle, Washington. June 21, 2010. Available at <http://www.wsdot.wa.gov/environment/air/piledrivigreports.htm>.
- 20) WSDOT. 2011a. Port Townsend Dolphin Timber Pile Removal – Vibratory pile monitoring Technical Memorandum prepared by Jim Laughlin for Rick Huey. Washington State Department of Transportation, Office of Air Quality and Noise, Seattle, Washington. January 2011.

September 2014

Appendix A

- 21) WSDOT. 2011b. Edmonds Ferry Terminal – Vibratory pile monitoring Technical Memorandum prepared by Jim Laughlin for John Callahan and Rick Huey, Washington State Department of Transportation, Office of Air Quality and Noise, Seattle, Washington, October 20, 2011.
- 22) WSDOT. 2012. Underwater vibratory sound levels from a steel and plastic on steel pile installation at the Anacortes Ferry Terminal. March 2012.

A-11

September 2014

Appendix A

THIS PAGE INTENTIONALLY LEFT BLANK

A-12

September 2014

Appendix B

Appendix B: Data Charts for Measured Data and Cumulative Probability Distribution Functions

September 2014

Appendix B

THIS PAGE INTENTIONALLY LEFT BLANK

September 2014

Appendix B

Appendix B: Data Charts for Measured Data and Cumulative Probability Distribution Functions

Impact RMS

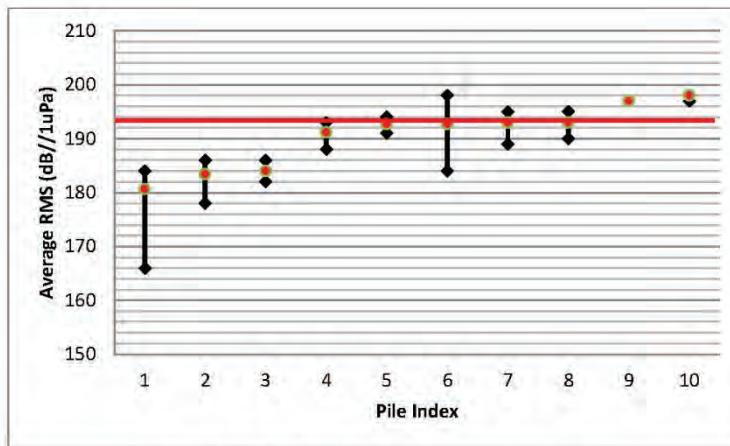


Figure B-1 – 24-inch RMS Measurements

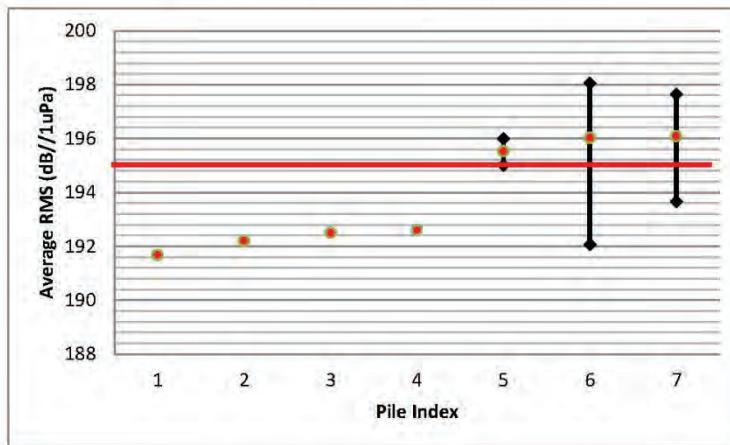


Figure B-2 - 30-inch RMS Measurements

B-1

September 2014

Appendix B

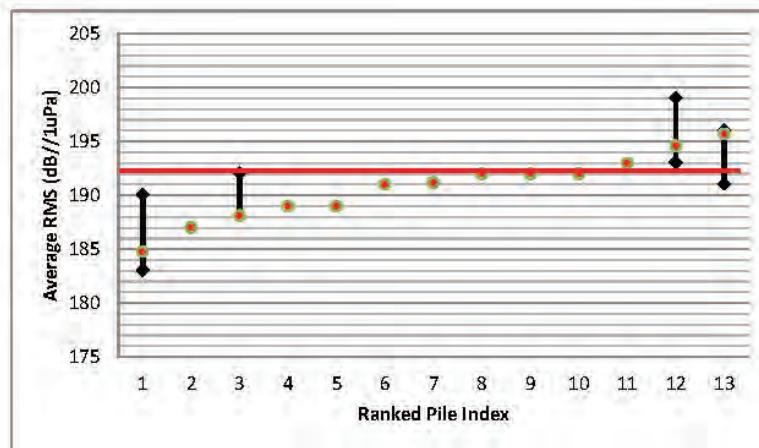


Figure B-3 – 36-inch RMS Measurements

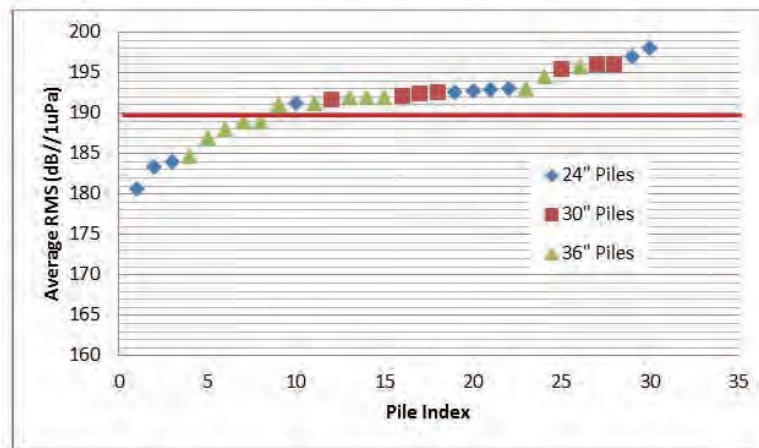
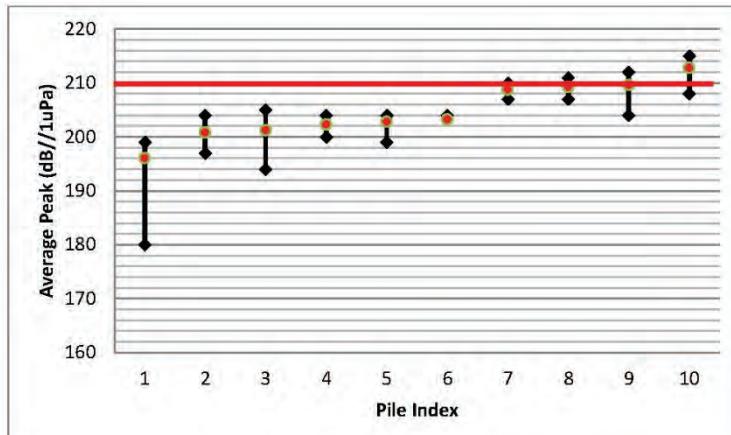
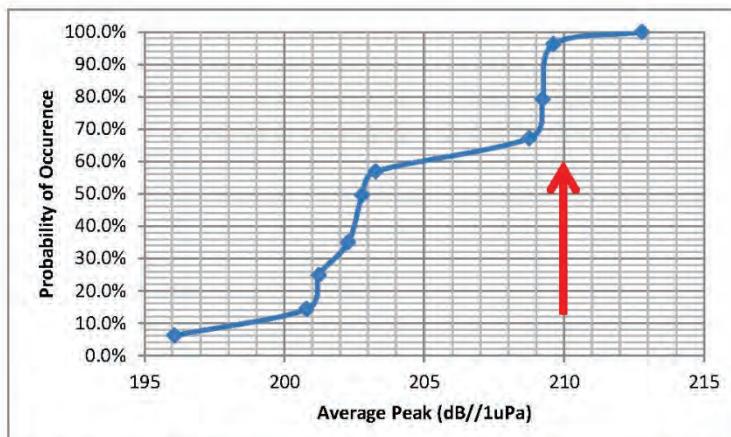


Figure B-4 – Combined Analysis: 24, 30, 36-inch RMS Measurements

September 2014

Appendix B

Impact Average Peak**Figure B-5 – 24-inch Average Peak Measurements****Figure B-6 – 24-inch Average Peak Cumulative Distribution Function**

September 2014

Appendix B

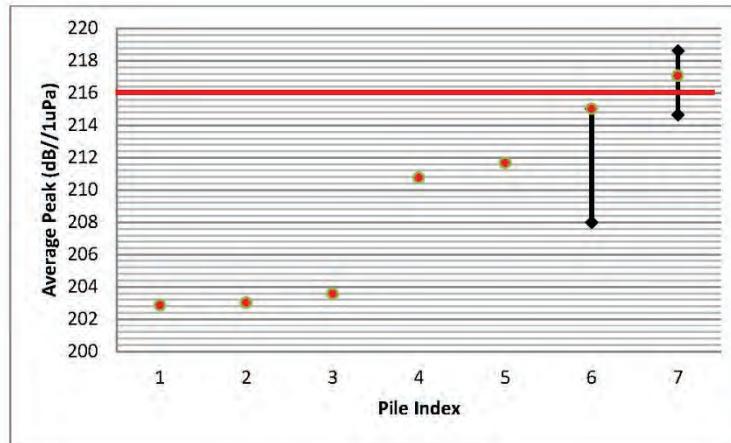


Figure B-7 – 30-inch Average Peak Measurements

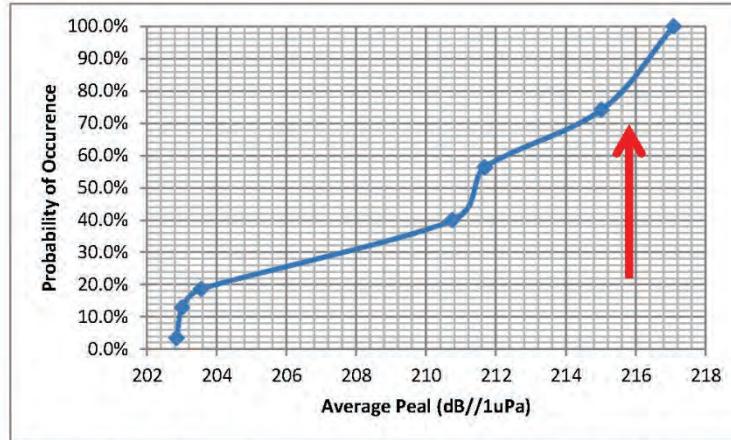


Figure B-8 – 30-inch Average Peak Cumulative Distribution Function

September 2014

Appendix B

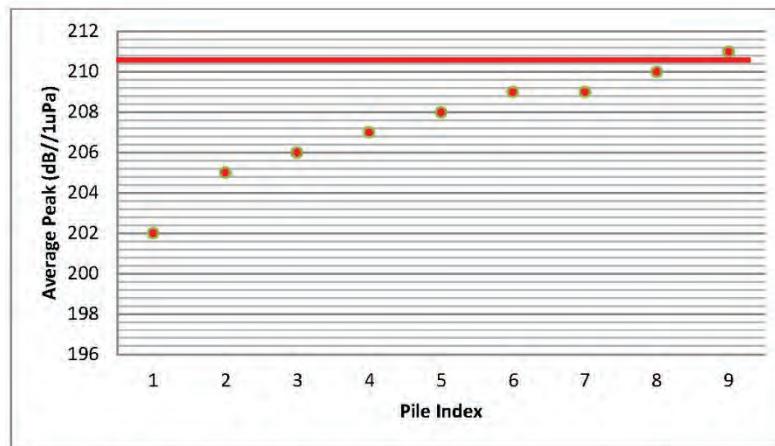


Figure B-9 – 36-inch Average Peak Measurements

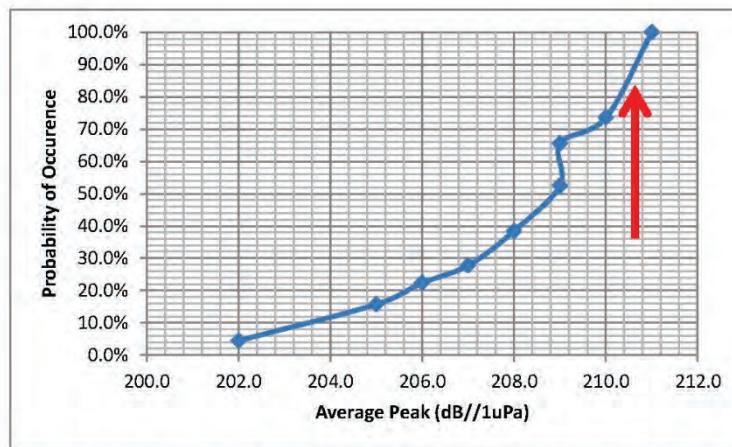


Figure B-10 – 36-inch Average Peak Cumulative Distribution Function

September 2014

Appendix B

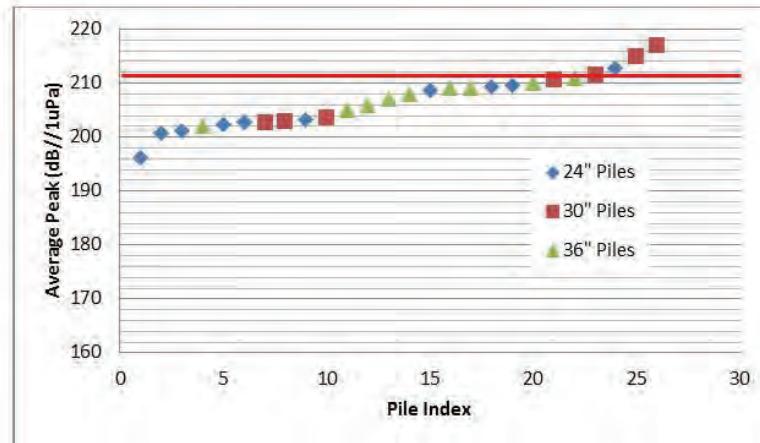


Figure B-11 – Combined Analysis: 24, 30, 36-inch Average Peak Measurements

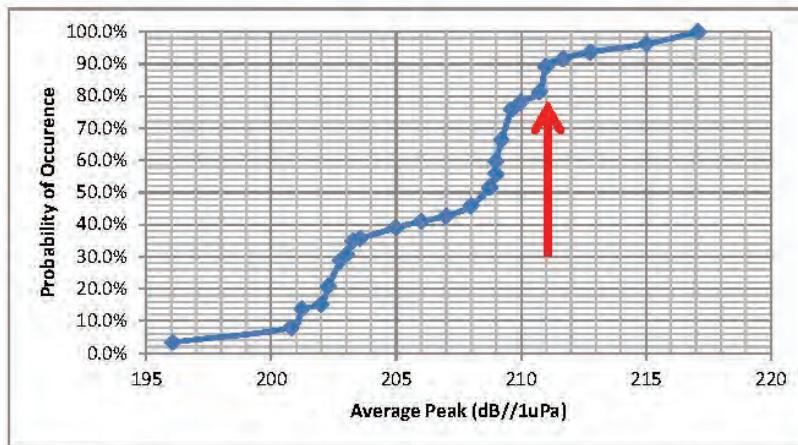
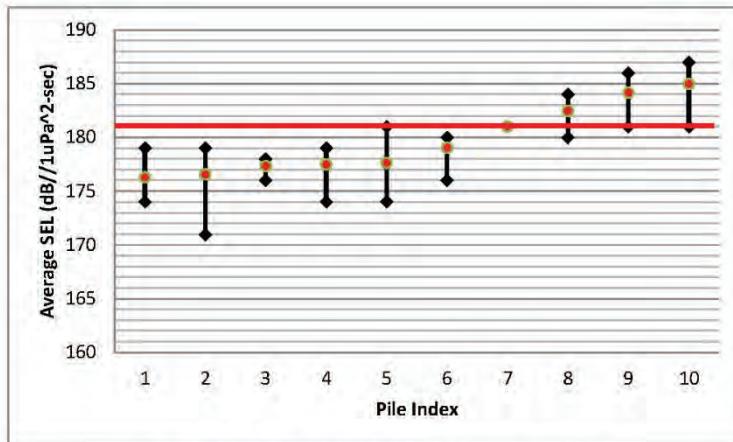
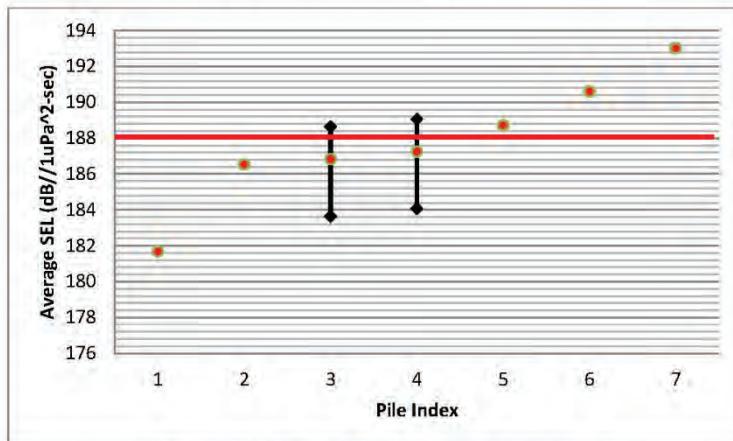


Figure B-12 –Combined Analysis: 24, 30, 36-inch Average Peak Cumulative Distribution Function

September 2014

Appendix B

Impact SEL**Figure B-13 – 24-inch SEL Measurements****Figure B-14 - 30-inch SEL Measurements**

September 2014

Appendix B

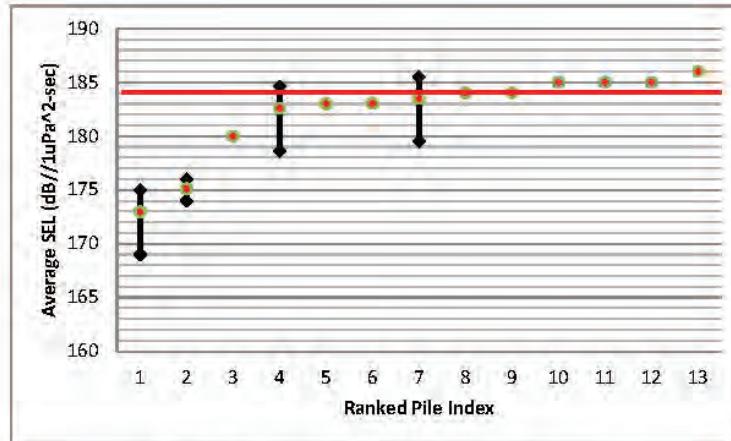


Figure B-15 – 36-inch SEL Measurements

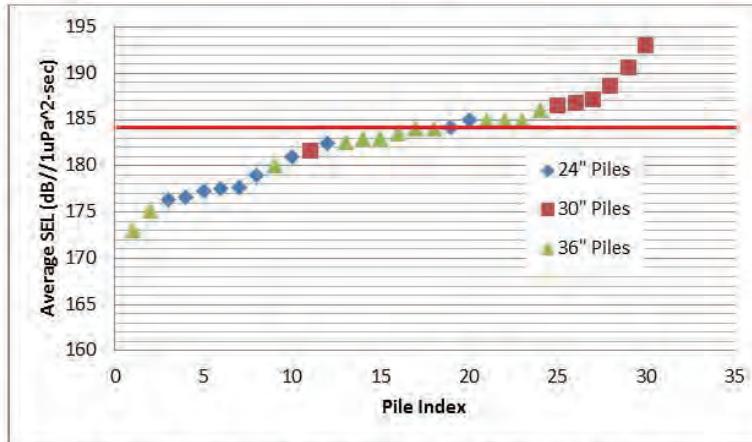


Figure B-16 - Combined Analysis: 24, 30, 36-inch SEL Measurements

September 2014

Appendix B

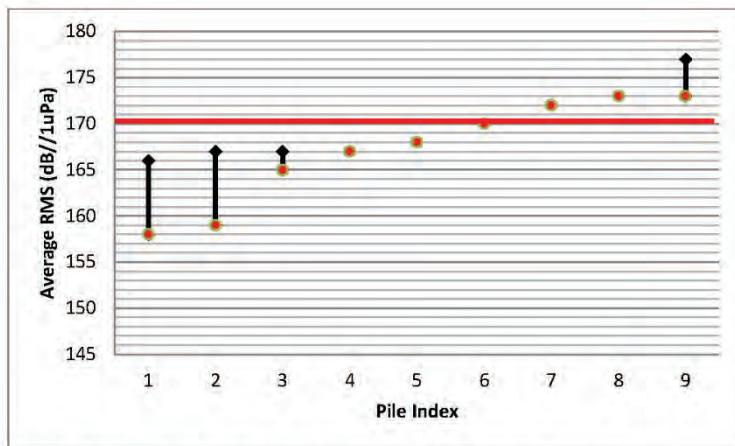


Figure B-17 – Concrete 16, 18-inch RMS Measurements

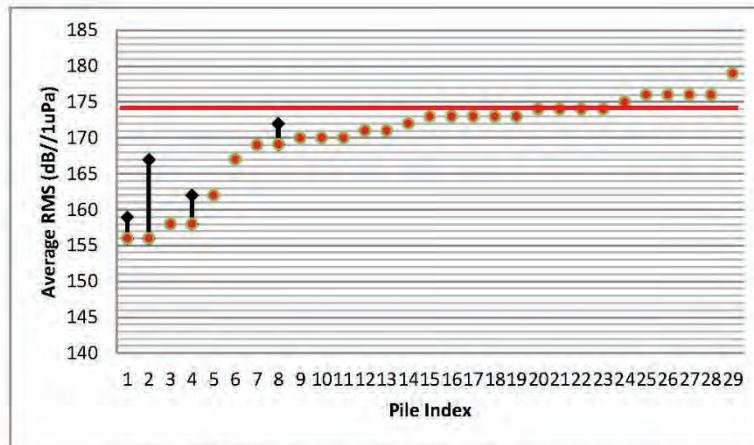


Figure B-18 – Concrete 24-inch RMS Measurements

September 2014

Appendix B

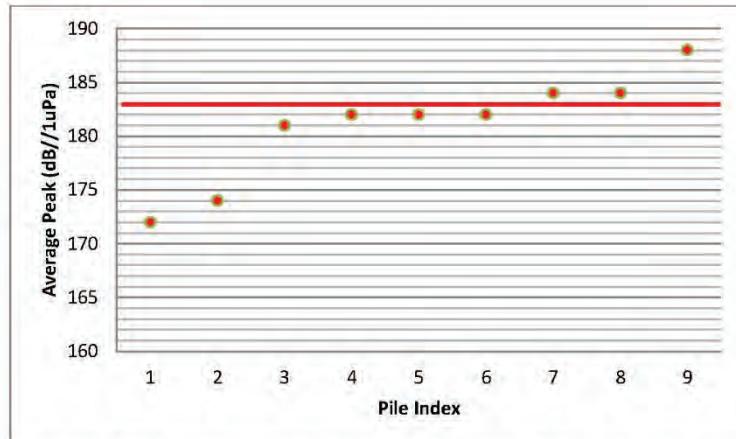


Figure B-19 – Concrete 16, 18-inch Average Peak Measurements

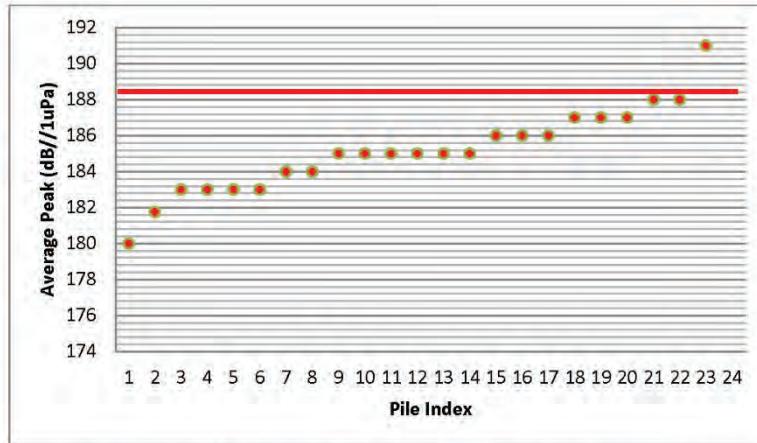


Figure B-20 – Concrete 24-inch Average Peak Measurements

September 2014

Appendix B

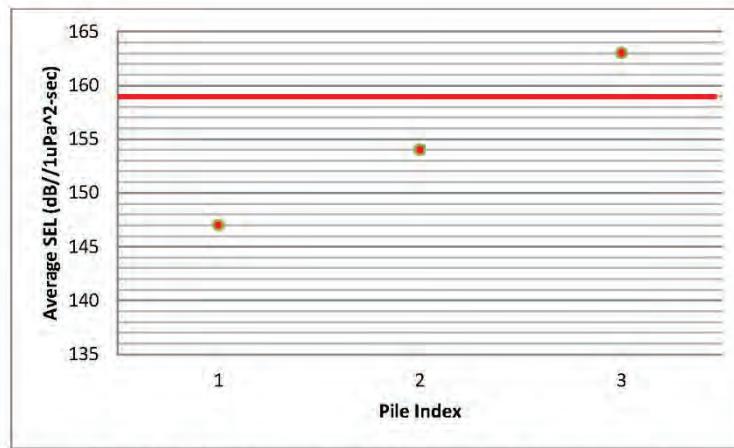


Figure B-21 – Concrete 16, 18-inch SEL Measurements

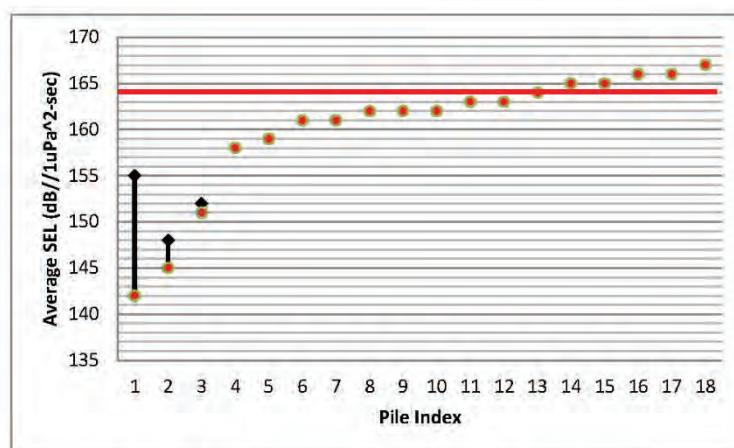
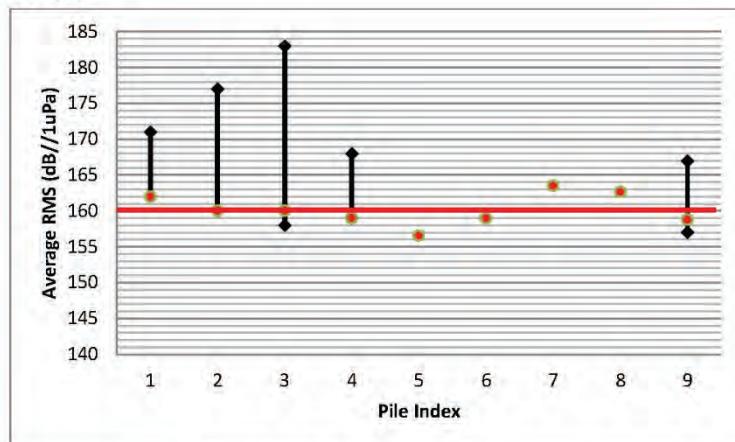
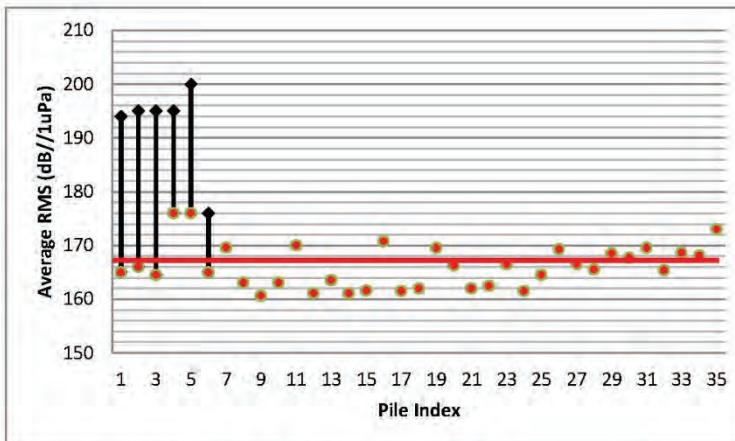


Figure B-22 – Concrete 24-inch SEL Measurements

September 2014

Appendix B

Vibratory RMS**Figure B-23 –24-inch RMS Vibratory Measurements****Figure B-24 –30-inch RMS Vibratory Measurements**

September 2014

Appendix B

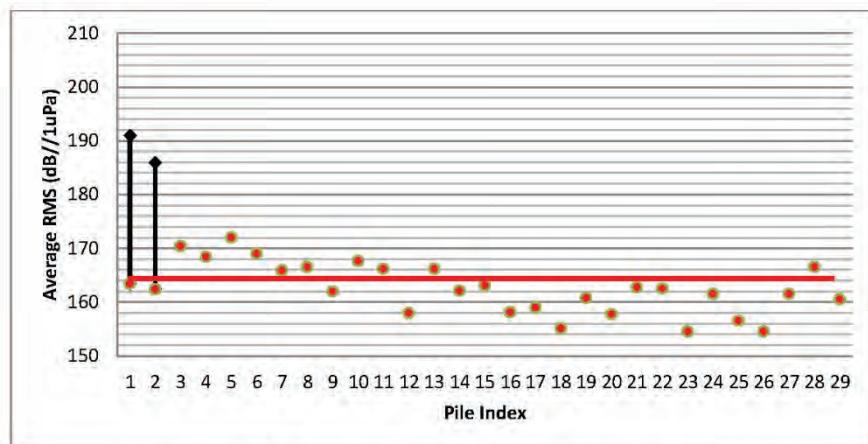


Figure B-25 –36-inch RMS Vibratory Measurement

B-13

September 2014

Appendix B

THIS PAGE INTENTIONALLY LEFT BLANK

B-14